MONITORING THE PESTICIDE TREATMENTS OF THE JAPANESE BEETLE PROJECT SACRAMENTO COUNTY, CALIFORNIA , 1983-1986

VOLUME III: DIAZINON

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Environmental Hazards Assessment Program

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MONITORING THE PESTICIDE TREATMENTS OF THE JAPANESE BEETLE ERADICATION PROJECT, SACRAMENTO COUNTY, CALIFORNIA, 1983 - 1986

VOLUME III: DIAZINON

BY

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ENVIRONMENTAL HAZARDS ASSESSMENT PROGRAM

ABSTRACT

The Japanese beetle has the potential of being a serious agricultural pest if it becomes established in California. Therefore, the Sacramento County Agriculture Department and the California Department of Food and Agriculture conducted a program to eradicate an infestation found in the Orangevale area. This program was initiated during the summer of 1983 and continued through the spring of 1986. The eradication program included six treatments of diazinon between 1983 and 1986. Each treatment consisted of three applications of diazinon to one or more of the following areas: turf, pasture, ornamental and fallow garden areas. Monitoring was conducted by the Environmental Hazards Assessment Program to determine the environmental distribution and fate of diazinon in turf/thatch, soil, air, fruit, and water.

Turf/thatch and soil were monitored at 17 locations before and after each application. Generally, the highest concentrations in turf/thatch were measured immediately after or day after application. The mean concentrations at that time ranged from 21 to 1700 mg/m^2, corresponding to 3.3 to 265% of the 641 mg/m^2 of diazinon used for each application. Concentrations declined to nondetectable levels two to three weeks after application.

Surface soil samples (0-2.5 cm depth) as well as deeper soil core samples (0-15 and 15-30 cm depths) were collected. Surface soil concentrations on the day after application ranged from 12 to 610 mg/m^2 or 0.32 to 17 ppm. For the 0-15 and 15-30 cm depths the highest concentrations were 2.5 and 2.8 ppm, respectively. Most of these samples contained no detectable diazinon (detection limit 0.1 ppm).

Air samples were collected before, during, and after application at a subset of the locations monitored for turf/thatch and soil. Concentrations ranged from 0.02 to 32 $\mu g/m^3$, below the American Conference of Governmental Industrial Hygienists', Threshold Limit Value of 100 $\mu g/m^3$. The volatilization rate, or evaporative flux, of diazinon was measured for one application. These measurements indicated that 57 mg/m^2 or 9% of the amount applied volatilized in the 30 hour period following application.

Fruit samples were collected from trees growing in treated turf and pasture areas. One fig sample (confirmed) and one persimmon sample (unconfirmed) contained 0.1 ppm of diazinon. The tolerance for figs is 0.5 ppm; no tolerance exists for persimmons.

Water monitoring occurred prior to treatment, during the fall 1984 treatment (irrigation runoff), and during rain runoff periods. The highest background concentration detected was 6.2 ppb. The highest concentration detected during the irrigation runoff period was 73 ppb, and the highest concentration during the rain runoff periods was 82 ppb. The amount of diazinon leaving the treatment area through runoff, or mass discharge rate, was estimated by multiplying the water concentration by the flow rate. The highest mass discharge rate measured during the fall 1984 irrigation runoff

was 7.8 g/hr and the total discharge during the six week treatment period was 3.1 kg or 0.11% of the total amount applied. The highest mass discharge rate measured during a rain runoff period was 24 g/hr. Even if this rate continued for 11 days, the total amount discharged would have been less than 1% of the diazinon applied. All samples collected from the American River by the California Department of Fish and Game showed no detectable diazinon. Samples collected from one well also showed no detectable residue.

The variability of residue concentrations in turf/thatch and soil made it difficult to estimate true concentrations, distribution in the different media, and dissipation rates. However, it appears that the majority of diazinon was confined to turf/thatch and the upper layers of soil and was virtually undetectable 21 days after application. It appears that some off-target movement occurred, mostly due to volatilization. However, low or non-detectable residue was found in fruit, ground water, or deeper soil layers.

PREFACE

This report is the third of three volumes describing the environmental monitoring of the pesticide treatment program to eradicate the Japanese beetle infestation in Sacramento County, California, 1983 - 1986. This program consisted of nine separate treatments (summer 1983, fall 1983, spring 1984, summer 1984, fall 1984, spring 1985, summer 1985, fall 1985, and spring 1986), with multiple applications of pesticides during each treatment. Three different pesticides were used during the program, carbaryl, isofenphos, and diazinon. This report presents the monitoring of the pesticide diazinon, Volume I describes the carbaryl monitoring and Volume II describes the isofenphos monitoring.

Each volume also has two companion documents. The first is a short executive summary which explains the monitoring program in lay terms. The second document is a supplement which contains the raw data summarized in the main report. Both of these documents are available on request.

The main sections of this report combine and summarize the monitoring of the six diazinon treatments: fall 1983, spring 1984, fall 1984, spring 1985, fall 1985 and spring 1986. Details of individual treatments are given in the appendices.

ACKNOWLEDGMENTS

The monitoring was conducted by the Environmental Hazards Assessment Program of the California Department of Food and Agriculture, under the direction of Ronald Oshima. The authors wish to thank the entire Program staff for their invaluable assistance.

We are indebted to the other individuals and agencies which provided cooperative monitoring and/or chemical analyses including the California Department of Fish and Game, the California Department of Health Services, the State Water Resources Control Board, the Central Valley Regional Water Quality Control Board, and the University of California.

Thanks are also extended to the Japanese Beetle Project personnel, and the Sacramento County Agriculture Department for their assistance.

DISCLAIMER

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INTRODUCTION

The Japanese beetle, Popillia japonica Newman, has the potential of being a serious agricultural pest if it becomes established in California. Damage occurs as the result of both larval and adult feeding. The larvae feed on the roots of plants, primarily grasses, while adult beetles can feed on the leaves, fruit, and flowers of over 300 plant species (Dowell, 1983). Areas in California with irrigated turf, and host plants for adults to feed on would be a suitable environment for the Japanese beetle.

Knowledge of the life cycle is crucial to the detection and eradication of Japanese beetle. During the summer the insect is in the adult stage and feeds on above ground portions of host plants. Also at this time, adults lay eggs in the soil. When eggs hatch in late summer the larvae feed on roots of plants, continue to feed through fall, and then become inactive in the winter. In the spring the larvae begin to feed again, pupate, and emerge as adults in early summer.

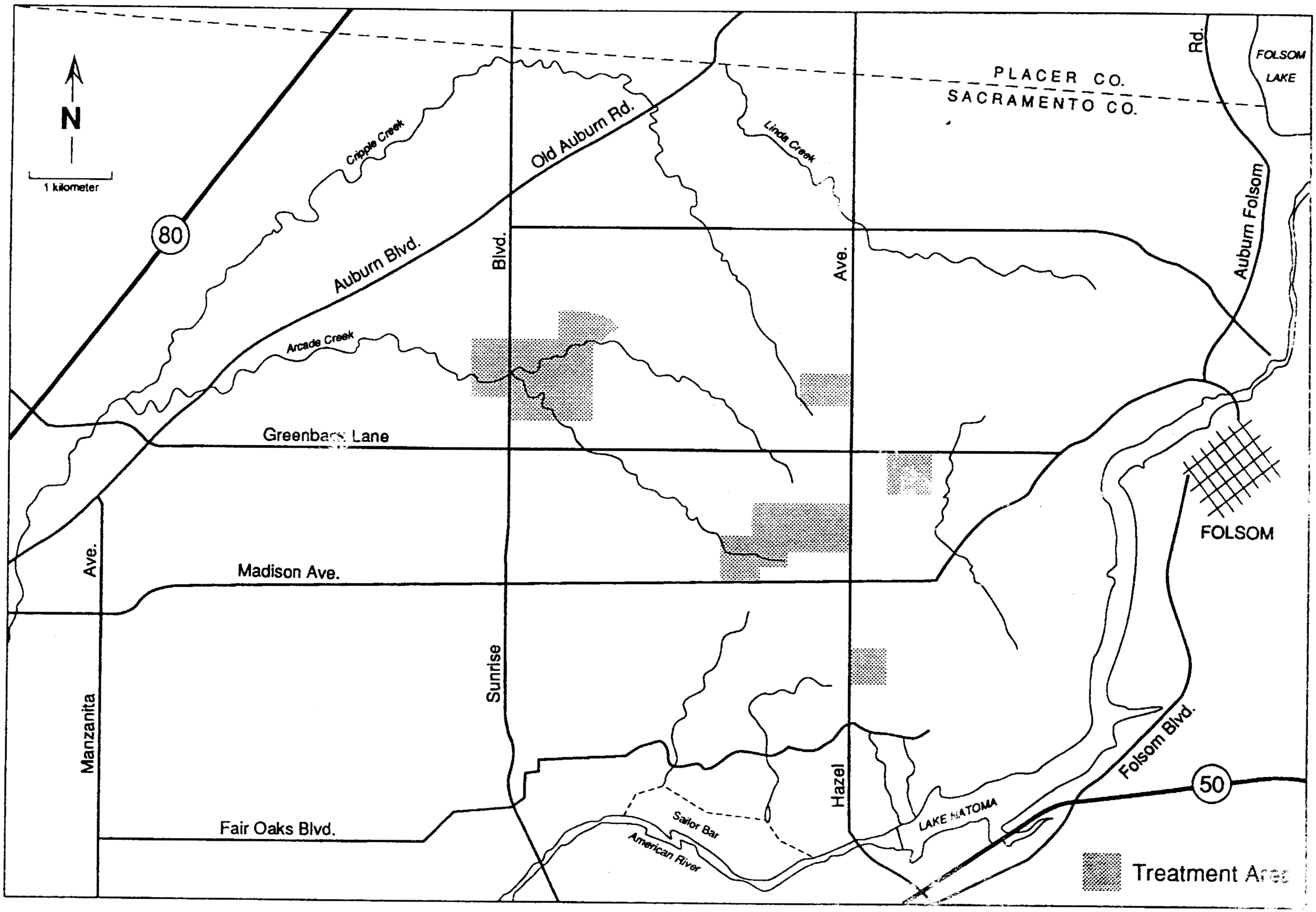
Detection and eradication activities were conducted by the Japanese Beetle Eradication Project, a cooperative effort of the Sacramento County Agriculture Department and the Pest Detection/Emergency Projects Branch of the California Department of Food and Agriculture (CDFA). Detection surveys were conducted in the summer when the adults could be trapped. This was the only time when a population could be detected and the area of the infestation determined. During the summer, the adult population was reduced by treating the foliage of host plants in the infested area with the pesticide carbaryl. During the fall and spring, soil applications of isofenphos and/or diazinon were made to turf, pasture, and fallow garden areas to reduce the larval populations. This two-phase treatment program was successful in eradicating the Japanese beetle infestation. This report describes the monitoring for diazinon; Volumes I and II describe the monitoring for carbaryl and isofenphos, respectively.

The monitoring of the diazinon treatments was conducted by the Environmental Hazards Assessment Program (EHAP) of the CDFA. The specific objectives of the diazinon monitoring program were to determine the environmental concentrations and fate of diazinon. Diazinon concentrations were measured in turf/thatch, soil, air, fruit, and water.

TREATMENT PROGRAM

The infestation was confined to the northern part of Sacramento County. The majority of the diazinon treatment areas were located in the town of Orangevale; parts of Fair Oaks and Citrus Heights were also included. The outermost boundaries are shown in Figure 1. Size of the treatment areas and location of the boundaries changed as new detection information was evaluated. Maps for specific treatments are shown in the appendices. Diazinon was applied to turf, pasture, and starting with the fall 1984 treatment, garden areas.

Figure 1. Diazinon treatment areas Japanese Beetle Project, Sacramento, 1983-86. The outermost boundaries are shown. Boundaries for specific treatments are shown in the appendices.



Two different formulations of diazinon were used during the program. A granular form of diazinon, Dzn 14G® was the most widely used. This formulation contained 14.3% diazinon as the active ingredient. An emulsifiable concentrate, Dzn AG500®, was used for turf treatment during the spring of 1984 only. This liquid formulation contained 48% by weight of diazinon, or 0.480 kilograms per liter. For application, the liquid diazinon was mixed with water to a concentration of 0.30% or 2.15%, depending on the type of site treated. Diazinon is an insecticide belonging to the organophosphate family with the following characteristics (Worthing, 1979):

Chemical name: 0,0-diethyl 0-[6-methyl-2-(1-methylethyl)-4-pyrimidinyl] phosphorothioate

Chemical Abstracts number: 333-41-5

Molecular weight: 304.3

Water solubility: 40 mg/L at room temperature

Vapor pressure: 1.4×10^{-4} torr at 20° C

LD50: 300-850 mg/kg, rat, oral

Tradenames: Basudin, Diazitol, Dzn, Neocidol, Spectracide

Granular diazinon was applied with a variety of fertilizer spreaders, just like the isofenphos. Liquid diazinon was applied using backpack sprayers. Each of the six diazinon treatments (fall 1983, spring 1984, fall 1984, spring 1985, fall 1985, spring 1986) consisted of three applications 10 - 14 days apart. Both formulations were applied at a rate of 6.41 kilograms active ingredient per hectare (5.72 pounds per acre). Immediately after application the turf was watered so the diazinon would penetrate into the soil. A total of 7877 kg of diazinon was applied for all six treatments combined (17,370 lb). Characteristics of each treatment are given in Table 1.

MATERIALS AND METHODS

The materials and methods for diazinon were very similar to those used for isofenphos. The details of those methods can be found in Volume II. One exception to this generalization involved the analysis of the oxygen analog breakdown product. Since the diazinon oxygen analog standard could not be obtained in suitable quantities, it was not analyzed for.

Turf/Thatch

In contrast to isofenphos, diazinon was applied to pastures and fallow garden areas as well as residential and school areas. Turf/thatch samples were collected from residential, school, and pasture areas. A total of 17 locations were monitored for turf/thatch residue at some time during the six diazinon treatments, between one and five locations for each treatment. Turf/thatch monitoring locations were selected primarily based on the amount and condition of the turf. In general, several locations were sampled the day after each of the three applications for each treatment, and a subset of these were also sampled on 5, 9, and 13 days after each application. Additional samples were collected on 17 and 21 days after the third and final application. Background samples were also collected prior to each of the six treatments.

Table 1. Characteristics of the diazinon treatments, Japanese Beetle Project, Sacramento, 1983-6.

Treatment	Application Period	Diazinon[a] Formulation	Type of Areas Treated	Amount of Diazinon Applied, kg
Fall 1983	Sep 6 - Oct 18	Dzn 14G®	pastures	648
Spring 1984	Mar 1 - Apr 30	Dzn 14G®	pastures	103
		Dzn AG500®	turf	515
Fall 1984	Aug 20 - Oct 3	Dzn 14G®	turf, pastures, ornamentals, gardens	2730
Spring 1985	Mar 1 - May 2	Dzn 14G®	turf, pastures, ornamentals, gardens	3310
Fall 1985	Aug 19 - Oct 10	Dzn 14G®	turf, pastures, ornamentals, gardens	380
Spring 1986	Mar 3 - Apr 21	Dzn 14G®	turf, pastures, ornamentals, gardens	191
				Total: 7877

a Dzn 14G® is a granular formulation, Dzn AG500® is an emulsifiable concentrate

Sampling and analytical methods were similar to those used for isofenphos. The only major difference was that the turf and thatch were combined into one sample. The samples were analyzed for dislodgable and internal diazinon by California Analytical Laboratories (CAL) using very similar methods to those for isofenphos. Split samples were analyzed by the CDFA laboratory for quality control. As with isofenphos, diazinon sample concentrations, weights and areas were used to calculate and report the results as mg/m^2.

The statistical analysis consisted of determining the mean for each site and sampling date, and then calculating a grand mean from the site means for each treatment. Analysis of variance was then used to examine differences over sampling days, applications and sites. Details of the statistical analysis is given in Appendix VII.

Soil

Soil residues were monitored at the same locations and same times as the turf/thatch. Samples were collected from the 0-2.5, 0-15 and 15-30 cm depths. Additional surface soil samples (0-2.5 cm) were collected from garden areas. The sampling methods were the same as for isofenphos. Soil was analyzed for diazinon by CAL using the isofenphos method. Split samples were analyzed by the CDFA laboratory. These results were also reported on a mg/m^2 and/or ppm, dry weight basis. The same statistical methods used for turf/thatch were used for soil.

Air

Air samples were collected from residential and school areas. Three to five locations were monitored for diazinon air concentrations during three of the six treatments. The air monitoring locations were selected based on the amount of turf area, electrical requirements, and ease of access.

Usually, the first two applications for each treatment were monitored. A series of four to six air samples were collected for each application. A 3-hour background sample was collected just prior to each application, followed by a series of 3-hr samples collected during the application and watering period. Two, 3-hour post-application samples were collected, one immediately after the application and watering sample, and one the day after application. This normal residential and school monitoring used the same sampling procedures as isofenphos.

For one liquid diazinon application during the spring of 1984 air flux measurements were made. The air flux monitoring measured air concentrations, wind speed, and temperature at different heights over a two day period. From these data the rate of volatilization from treated turf was calculated by the University of California, Environmental Toxicology Department (UCD) using the aerodynamic methods of Caro (1971) and Parmele (1972).

All diazinon air samples were analyzed by the CDFA laboratory. The analytical methods were similar to those used by UCD for isofenphos. For quality control a trapping efficiency test was conducted, similar to the one used for isofenphos. The air concentrations were reported as $\mu g/m^3$, while the flux values were reported as $mg/m^2/hr$.

Fruit

Fruit samples were collected from trees that were planted in treated areas. Samples of apples, apricots, berries, cherries, fava beans, figs, grapes, grapefruit, lemons, limes, loquats, oranges, peaches, pecans, persimmons, pomegranates, and walnuts were collected from one to nine locations at some time during the treatment program. Since all gardens were fallow at the time of treatment, no commodity samples were obtained from these areas.

Fruit sampling was conducted during four of the six treatments. As with isofenphos, samples were collected during the preharvest and harvest intervals. These intervals varied from 7 to 140 days after application. Sampling and analytical methods were the same as isofenphos. The analyses were conducted by CAL and the CDFA laboratory for diazinon, and the results were reported in ppm, fresh weight basis.

Water

Water samples were collected from creeks and one well. The number and location of the creek monitoring sites varied as the areas treated changed from season to season. Like isofenphos, the sampling sites were located where the highest concentrations were expected, just downstream of the treatment areas. All creeks that drained any part of the treatment areas were monitored.

Surface water samples were collected from creeks during three different periods: background monitoring before each season's treatment, irrigation runoff monitoring during the fall 1984 treatment, and rain runoff monitoring during each treatment's rainfall season. Only one well was found in any of the treatment areas, and it was sampled periodically.

Water monitoring was also conducted by the California Department of Fish and Game's Pesticide Investigations Unit (CDFG). They collected water samples from the American River area to determine possible impacts to fish, particularly those located in their fish hatchery near Nimbus Dam.

The water sampling methods were the same as those used for isofenphos. The samples were analyzed by CAL using their normal organophosphate method. Split samples were also analyzed by the CDFA laboratory. Results were reported as ppb. The concentrations were multiplied by the water flow rates to also obtain the mass discharge rates in µg/sec or g/hr.

RESULTS AND DISCUSSION

The results for all treatments combined are summarized in this section; details for individual treatments are found in the appendices.

Turf/Thatch

Results of the quality control samples were generally good. The 35 laboratory-spiked samples were analyzed for total residue (dislodgable + internal) and had an average recovery of 96.7% with a standard deviation of 13.4. It was difficult to make a good analysis of the agreement between CAL and the CDFA laboratory because all of the split samples contained very low concentrations, with a large proportion of them being negative. The data in Table 2 show that the CDFA laboratory had a significantly higher proportion of positives for both dislodgable and internal. Also, the mean of the samples found postive by both labs was significantly higher for CDFA for dislodgable, but not internal residues.

Diazinon turf/thatch data reported previously in a series of memorandums do not agree with the data presented here for two reasons. First, the results reported previously were calculated assuming negative samples were zeros. The results presented here were calculated assuming the concentrations of negative samples were one-half the detection limit. A detailed explanation for making this assumption is given in Volume II, Appendix I. Briefly, all that is known about these samples is that they lie somewhere between zero and the detection limit. In the absence of any other information, the value half-way between zero and the detection limit is a more reasonable approximation than simply using zero. Second, the units used previously were mg/ft^2, while the units used here are mg/m^2. To convert one to the other the concentrations in mg/ft^2 are multiplied by 10.76 to obtain concentrations in mg/m^2.

Table 2. Results of the diazinon turf/thatch samples split between CAL and CDFA, Japanese Beetle Project, Sacramento, 1983-6.

	Number of Samples	
	Dislodgable	Internal
Total split samples	29	29
Both labs negative	8	2
CAL positive, CDFA negative	0	0
CDFA positive, CAL negative	6	9
Both labs positive[a]		
CAL higher than CDFA	4	9
CDFA higher than CAL	11	9

a The CAL and CDFA dislodgable mean values were 4.12 and 6.45 ppm, respectively. The CAL and CDFA internal mean values were 15.6 and 21.3 ppm, respectively.

The turf/thatch concentrations were highly variable with site means ranging from none detected (detection limit approximately 2 mg/m^2, varying according to sample weight) to 1700 mg/m^2 over the 21 day sampling period. The highest concentrations were usually found the day of or day after application. Site mean concentrations on those days ranged from 21 to 1700 mg/m^2, 3.3 to 265% of the 641 mg/m^2 theoretical application rate. A summary of the turf/thatch concentrations for each treatment and sampling period is shown in Table 3. Dislodgable residues were determined for the fall 1984 and spring 1985 treatments. The dislodgable residues were generally a small fraction of the total diazinon, ranging from 0.20 to 330 mg/m^2.

Table 3. Summary of mean total (dislodgable + internal) diazinon concentrations in turf/thatch, Japanese Beetle Project, Sacramento, 1983-6. Overall mean values for each day within a treatment are calculated from the site means. Samples below the detection limit are calculated as 1/2 the detection limit. The fall 1983 and spring 1984 treatments were sampled on a different schedule and are not included in this table.

Sampling Day	Mean Diazinon Concentration, mg/m² (# of sites)							
	Fall 1984		Spring 1985		Fall 1985		Spring 1986	
Application 1								
Background	ND[a]	(5)	ND	(3)	ND	(1)	ND	(1)
1	190	(5)	450	(3)	220	(1)	230	(1)
5	120	(4)	440	(3)	110	(1)	41	(1)
9	32	(5)	210	(2)	74	(1)	29	(1)
13	16	(4)	not sampled		not sampled		5.8	(1)
Application 2								
1	97	(4)	230	(2)	170	(1)	93	(1)
5	38	(5)	43	(3)	140	(1)	94	(1)
9	41	(5)	65	(3)	160	(1)	68	(1)
13	12	(4)	35	(1)	22	(1)	26	(1)
Application 3								
1	230	(5)	200	(3)	130	(1)	490	(1)
5	200	(5)	120	(3)	110	(1)	77	(1)
9	20	(5)	54	(3)	53	(1)	15	(1)
13	4.7	(5)	26	(3)	13	(1)	5.4	(1)
17	5.0	(5)	64	(3)	not sampled		not sampled	
21	5.6	(5)	36	(3)	not sampled		not sampled	

a ND - None Detected, with a detection limit of approximately 2 mg/m².

Not reflected in Table 3 is the high variation associated with each treatment. Standard deviations as high as the mean were not uncommon. Most of the variation was probably due to the variation inherent in granular applications. Each granule represented a significant proportion of the residue in an individual sample; therefore, even small variations in the spatial distribution of the granules created large variations in pesticide concentration of the samples.

The monitoring data collected from the last four treatments, fall 1984 through spring 1986, was subjected to analysis of variance (ANOVA) to determine the patterns over time and application. Most of the data were collected during the fall 1984 and spring 1985 treatments, when the greatest amount of diazinon was applied. Therefore, the most detailed and valid analyses were made with these data. The fall 1983 and spring 1984 data were excluded because they were sampled on different days. The fall 1984 and spring 1985 data revealed some significant trends (Table 4). However, individual sites differed significantly from the overall pattern. Dissipation occurred between applications and after the last application because there were significant differences between days 1, 5, and 9. The pattern among applications was for application 1 to have higher overall levels than application 2 or application 3. Therefore, there was no accumulation of diazinon from the first to the third application. Spring 1985 had a higher level of diazinon overall than did fall 1984. Since they were the only two treatments for which the data were combined, comparison to the other treatments was not possible. The separate ANOVA's of the fall

1985 and spring 1986 data showed similar patterns of dissipation over days and applications.

The dislodgable fraction showed a similar pattern as the total residue. For the fall 1984 and spring 1985 treatments significant differences were found between day 1, 5, and 9 after the third application (Table 5). Details of the statistical analyses are given in Appendix VII.

It is important to note that the disappearance of diazinon over time in this study is dissipation, which may include degradation. Degradation (transformation of the parent compound into one or more different compounds) is a contributing factor in dissipation, but not the only factor. Other processes which influenced the dissipation rate of diazinon include volatilization, leaching, runoff, turf growth, foot traffic and mowing.

Comparison of these data to those obtained from the isofenphos treatment showed that the concentrations in turf and thatch were much higher for diazinon than isofenphos. This was expected since diazinon was applied at a much higher rate than isofenphos (641 vs. 224 mg/m^2). In addition, three diazinon applications were made for each treatment, while only one was used for the isofenphos treatment. Also expected was the difference in dissipation rates. The diazinon dissipation rate was measured in days, while the isofenphos dissipation rate was measured in weeks.

Table 4. Main effect means for diazinon concentration in turf/thatch samples, fall 1984 and spring 1985, Japanese Beetle Project, Sacramento, 1983-6.

Factor		Mean Concentration, mg/m^2
Day	1	223
	5	152
	9	54.2
Application	1	214
	3	140
	2	71.2
Treatment	fall 1984	108
	spring 1985	200

Note: Means connected by vertical lines are not significantly different.

Table 5. Day main effect means for dislodgable diazinon concentration in turf/thatch samples after the third application, fall 1984 and spring 1985, Japanese Beetle Project, Sacramento, 1983-6.

Day	Mean Concentration, mg/m^2
1	39.8
5	13.6
9	7.59
13	2.26
17	6.18
21	3.85

Note: Means connected by vertical line are not significantly different. Day 21 was not included in the statistical analysis since most samples were non-detects (one-half the detection limit was substituted for these values in calculating the mean).

Previous work indicates that 72 to 98% of the applied diazinon was found in the turf and thatch layers immediately after application (Sears, et al, 1987; Sears and Chapman, 1979). Concentrations found during this monitoring were much more variable (3 to 265%), but generally lower. Dissipation rates were approximately the same; two weeks after application Sears found 2 to 9% of the applied diazinon versus 0.3 to 22% found here.

Soil

Results of the quality control samples were generally good. The 52 laboratory-spiked samples had an average recovery of 93.7% with a standard deviation of 9.6. As with turf/thatch samples, it was difficult to make a comparison of the samples split between CAL and the CDFA laboratory because of the low concentrations and high proportion of negative samples. The data in Table 6 show that the CDFA laboratory reported a higher proportion of positive samples than CAL ($p<.05$) and higher mean concentration for those samples reported positive by both labs ($p<.05$).

As explained in the turf/thatch section the data presented here do not agree with data previously reported because negative samples were treated differently and the units were changed from mg/ft^2 to mg/m^2.

Table 6. Results of the diazinon soil samples split between CAL and CDFA, Japanese Beetle Project, Sacramento, 1983-6.

	Number of Samples
Total split samples	105
Both labs negative	46
CAL positive, CDFA negative	1
CDFA positive, CAL negative	22
Both labs positive[a]	
CAL higher than CDFA	4
CDFA higher than CAL	31
CAL and CDFA equal	1

a The CAL and CDFA mean values were 4.47 and 6.16 ppm, respectively.

As with turf/thatch the soil sample variablity was very high, precluding precise conclusions about the data. The results of the soil monitoring showed that the great majority of the diazinon present in soil was contained in the 0-2.5 cm layer. Site mean concentrations in this layer ranged from none detected (detection limit 3 mg/m^2 or 0.1 ppm) to 760 mg/m^2 or 23 ppm, corresponding to 119% of the 641 mg/m^2 diazinon applied. As with turf/thatch the highest concentrations were found the day after application. Site mean concentrations during this period ranged from 12 to 610 mg/m^2 or 0.32 to 17 ppm. Soil concentrations in the 0-2.5 cm depth are summarized in Tables 7 and 8. The fall 1983 and spring 1984 treatments were not included because this depth was not sampled during those treatments.

Table 7. Summary of mean diazinon concentrations in soil (0-2.5 cm, mg/m^2), Japanese Beetle Project, Sacramento, 1983-6. Overall mean values for each day within a treatment are calculated from the site means. Samples below the detection limit are calculated as 1/2 the detection limit. The fall 1983 and spring 1984 treatments were sampled on a different schedule and are not included in this table.

Sampling Day	Mean Diazinon Concentration, mg/m^2 (# of sites)			
	Fall 1984	Spring 1985	Fall 1985	Spring 1986
Application 1				
Background	ND[a] (5)	ND (3)	ND (1)	ND (1)
1	290 (5)	300 (3)	66 (1)	200 (1)
5	190 (4)	300 (3)	80 (1)	160 (1)
9	58 (5)	120 (2)	26 (1)	72 (1)
13	21 (4)	not sampled	not sampled	18 (1)
Application 2				
1	77 (4)	190 (2)	120 (1)	140 (1)
5	43 (5)	34 (3)	54 (1)	39 (1)
9	15 (5)	82 (3)	120 (1)	ND (1)
13	3.1 (4)	57 (1)	20 (1)	4.0 (1)
Application 3				
1	160 (5)	390 (3)	45 (1)	42 (1)
5	60 (5)	96 (3)	74 (1)	140 (1)
9	5.1 (5)	130 (3)	15 (1)	150 (1)
13	3.0 (5)	63 (3)	23 (1)	ND (1)
17	2.9 (5)	110 (3)	not sampled	not sampled
21	ND (5)	56 (3)	not sampled	not sampled

a ND - None Detected, with a detection limit of approximately 3 mg/m^2

Table 8. Summary of mean diazinon concentrations in soil (0-2.5 cm, ppm), Japanese Beetle Project, Sacramento, 1983-6. Overall mean values for each day within a treatment are calculated from the site means. Samples below the detection limit are calculated as 1/2 the detection limit. The fall 1983 and spring 1984 treatments were sampled on a different schedule and are not included in this table.

Sampling Day	Mean Diazinon Concentration, ppm (# of sites)			
	Fall 1984	Spring 1985	Fall 1985	Spring 1986
Application 1				
Background	ND[a] (5)	ND (3)	ND (1)	ND (1)
1	7.9 (5)	8.0 (3)	1.9 (1)	4.5 (1)
5	5.4 (4)	9.4 (3)	3.1 (1)	4.7 (1)
9	1.7 (5)	3.6 (2)	0.63 (1)	1.8 (1)
13	0.57 (4)	not sampled	not sampled	0.47 (1)
Application 2				
1	2.4 (4)	6.2 (2)	3.1 (1)	3.7 (1)
5	1.9 (5)	1.7 (3)	1.6 (1)	0.90 (1)
9	0.53 (5)	1.1 (3)	4.4 (1)	ND (1)
13	0.11 (4)	1.6 (1)	0.67 (1)	0.10 (1)
Application 3				
1	5.0 (5)	15 (3)	1.8 (1)	1.1 (1)
5	2.0 (5)	3.6 (3)	2.6 (1)	4.8 (1)
9	0.16 (5)	6.0 (3)	0.50 (1)	4.6 (1)
13	0.13 (5)	2.6 (3)	0.87 (1)	ND (1)
17	0.08 (5)	4.6 (3)	not sampled	not sampled
21	ND (5)	2.3 (3)	not sampled	not sampled

a ND - None Detected, with a detection limit of 0.1 ppm

The same ANOVA techniques used to determine the turf/thatch dissipation were used for soil. Only data from the 0-2.5 cm depth was evaluated, since the other depths contained too many negative samples for this analysis. Again, the most data were collected for the fall 1984 and spring 1985 treatments and the most valid comparisons were made with these data. The patterns of dissipation found in the 0-2.5 cm soil depth during the fall 1984 and spring 1985 treatments were slightly different from those found for turf/thatch. Within each application, significant dissipation occurred between days 1 and 5. Concentrations decreased between days 5 and 9, but the decrease was not statistically significant in spring 1985 (Table 9). Concentrations between days 9, 13, and 17 after the final application were also not significantly different. As with turf/thatch, some of the sites were significantly different from the overall pattern. The last two treatments, fall 1985 and spring 1986, were analyzed separately and they differed from the overall pattern. In fact, in a few instances increases in concentration occurred over time. The pattern of less dissipation than turf/thatch is not surprising, since any irrigation or rainfall could move diazinon out of the turf/thatch layer and into the soil. The pattern of applications within each treatment was similar to turf/thatch. Within each treatment, application 1 usually had the highest concentrations with application 3 having less and application 2 having the least, indicating that no accumulation of diazinon occurred between applications.

Table 9. Treatment means by day for diazinon concentration in soil samples (0-2.5 cm), fall 1984 and spring 1985, Japanese Beetle Project, Sacramento, 1983-6.

	Mean Concentration, mg/m²		
Day	Fall 1984	Spring 1985	Combined
1	181	306	227
5	90.4	144	111
9	26.0	110	55.3

Note: Means in rows and/or columns connected by lines are not significantly different.

The 0-15 and 15-30 cm depths had lower concentrations than the 0-2.5 cm depth. The 0-15 cm concentrations are summarized in Table 10. Site mean concentrations ranged from none detected (detection limit 0.1 ppm) to 2.5 ppm. The 15-30 cm depth was sampled only during the spring 1984, fall 1984 and spring 1985 treatments. Site mean concentrations ranged from none detected (detection limit 0.1 ppm) to 2.8 ppm, with the majority of the samples below the detection limit (Appendices II, III, and IV). Because of the large proportion of negative samples these data were not statistically analyzed. Table 11 shows the percent of positive samples was greater for the fall 1984 treatment than the spring 1985 treatment. However, fewer samples were collected during the spring 1985 treatment, so the fluctation in percentage is not as meaningful as they might appear.

Table 10. Summary of mean diazinon concentrations in soil (0-15 cm, ppm), Japanese Beetle Project, Sacramento, 1983-6. Overall mean values for each day within a treatment are calculated from the site means. Samples below the detection limit are calculated as 1/2 the detection limit. The fall 1983 and spring 1984 treatments were sampled on a different schedule and are not included in this table.

Sampling Day	Mean Diazinon Concentration, ppm (# of sites)			
	Fall 1984	Spring 1985	Fall 1985	Spring 1986
Application 1				
Background	ND[a] (5)	ND (3)	ND (1)	ND (1)
1	0.70 (5)	0.06 (3)	0.07 (1)	ND (1)
5	0.37 (4)	ND (3)	ND (1)	0.53 (1)
9	0.14 (5)	0.14 (2)	ND (1)	0.47 (1)
13	0.08 (4)	not sampled	not sampled	ND (1)
Application 2				
1	0.73 (4)	0.48 (2)	ND (1)	0.15 (1)
5	0.12 (5)	ND (3)	0.10 (1)	0.15 (1)
9	0.06 (5)	0.11 (3)	0.10 (1)	0.50 (1)
13	ND (4)	ND (1)	0.22 (1)	ND (1)
Application 3				
1	0.58 (5)	0.07 (3)	0.12 (1)	ND (1)
5	0.23 (5)	ND (3)	0.13 (1)	ND (1)
9	ND (5)	0.08 (3)	ND (1)	ND (1)
13	ND (5)	ND (3)	ND (1)	ND (1)
17	ND (5)	ND (3)	not sampled	not sampled
21	ND (5)	0.09 (3)	not sampled	not sampled

a ND - None Detected, with a detection limit of 0.1 ppm

Table 11. Percent of soil samples (0-15 and 15-30 cm depth) positive for diazinon, fall 1984 and spring 1985, Japanese Beetle Project, Sacramento, 1983-6.

	Percent Positive			
	Fall 1984		Spring 1985	
Day Sampled	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Application 1				
1	67	40	11[a]	0
5	83	17	0	0
9	53	7	50	33
Application 2				
1	58	42	33	0
5	40	20	0	0
9	7	0	11	0
Application 3				
1	40	20	11	0
5	40	20	0	0
9	0	13	11	11
13	0	0	0	11

a In spring 1985, 11% positive represents one positive sample out of a total of nine samples.

Soil from fallow garden areas was sampled during the fall 1984 treatment. These concentrations were much higher because the diazinon was applied directly to bare soil (Table 12). Site mean concentrations ranged from 25 to 590 mg/m^2 or 0.73 to 14 ppm, corresponding to 4 to 92% of the applied diazinon.

As with turf/thatch, differences were observed between diazinon and isofenphos soil concentrations. Diazinon concentrations (0-2.5 cm) found 5 to 13 days after application were similar to those found 8 to 20 weeks after the isofenphos application, indicating that the diazinon dissipation rate was much higher than isofenphos. The difference is even more pronounced considering that the diazinon application rate was also much higher. Concentrations at the deeper depths were more similar, with both pesticides detected in only a small percentage of samples.

Extensive work has been done with diazinon in soil. However, most of the research has involved the application of diazinon directly to soil rather than to turf as was done here. Kuhr and Tashiro (1978) applied diazinon in both liquid and granular forms to turf at a rate of 6.72 kg/ha. They found 61% of the granular diazinon in the 0-5.1 cm depth just after application and watering, and 63% of the liquid diazinon. They also found that diazinon concentrations remained level for about two weeks, probably because of movement from turf to soil. On the other hand, Sears and Chapman (1979) found only 2% of the applied diazinon in the 0-1 cm depth just after application, and less than 1% after 14 days. The difference was probably

Table 12. Mean diazinon concentrations in garden soil (0-2.5 cm), fall 1984, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the two site (Locations 52, 66) means. Values below the detection limit are calculated as 1/2 the detection limit.

Sampling Day	# of Sites	Diazinon, mg/m^2	Diazinon, ppm
Application 1			
Background	2	ND (0.05)[a]	ND (0.05)
1	2	590	14
5	2	310	9.4
9	2	170	4.5
13	2	110	4.1
Application 2			
1	2	570	13
5	2	360	8.2
9	2	360	6.5
13	2	330	6.7
Application 3			
1	2	510	11
5	2	330	6.1
9	2	220	4.4
13	2	320	6.7
17	2	120	2.2
21	2	25	0.73

a ND - None Detected, with the value indicating 1/2 the detection limit

due to the presence of a thatch layer in the Sears and Chapman study, but not the Kuhr and Tashiro study. These studies demonstrate that the thatch layer plays a crucial role in determining the amount of diazinon that reaches the soil after application to turf.

Air

The results of the trapping efficiency test showed that 91% of the 3700 µg of spiked diazinon was trapped by the high volume air samplers. The samplers in this test were run for six hours at 0.85 m^3/min. Several of the highest diazinon samples were analyzed by mass spectrometry for the diazinon oxon oxidation product, none was detected at a level one-tenth of the diazinon concentration.

The results of the air monitoring are shown in Table 13. The data show that diazinon air concentrations were approximately 1000 times higher than isofenphos concentrations. The maximum diazinon concentration found was 32 µg/m^3 or 32000 ng/m^3, while the maximum isofenphos concentration was 46 ng/m^3 (see Volume II). Additionally, it appears as if the air concentrations from liquid diazinon applications were higher than those from granular applications. This trend where liquid diazinon > granular diazinon > isofenphos is probably due to differences in volatility. Diazinon has a much greater vapor pressure than isofenphos (1.4×10^{-4} vs 4×10^{-6} torr) and liquid formulations are generally more volatile than granular formulations. As expected, the highest concentrations occurred during pesticide application, and lower concentrations after application. However, all samples including backgrounds were positive, indicating that low levels of diazinon were present in air throughout the 6-week treatment periods.

All samples were below the American Conference of Governmental Industrial Hygienists', Threshold Limit Value of 100 $\mu g/m^3$ for occupational exposures, and substantially agree with the levels found by Weisskopf, et al (1988), who monitored the worker exposure to granular diazinon during the Japanese Beetle Project. They found that with the exception of belly grinder applicators, the respiratory exposure ranged from 2 to 13 $\mu g/m^3$. The concentrations found during granular applications in our monitoring ranged from 0.37 to 9.9 $\mu g/m^3$.

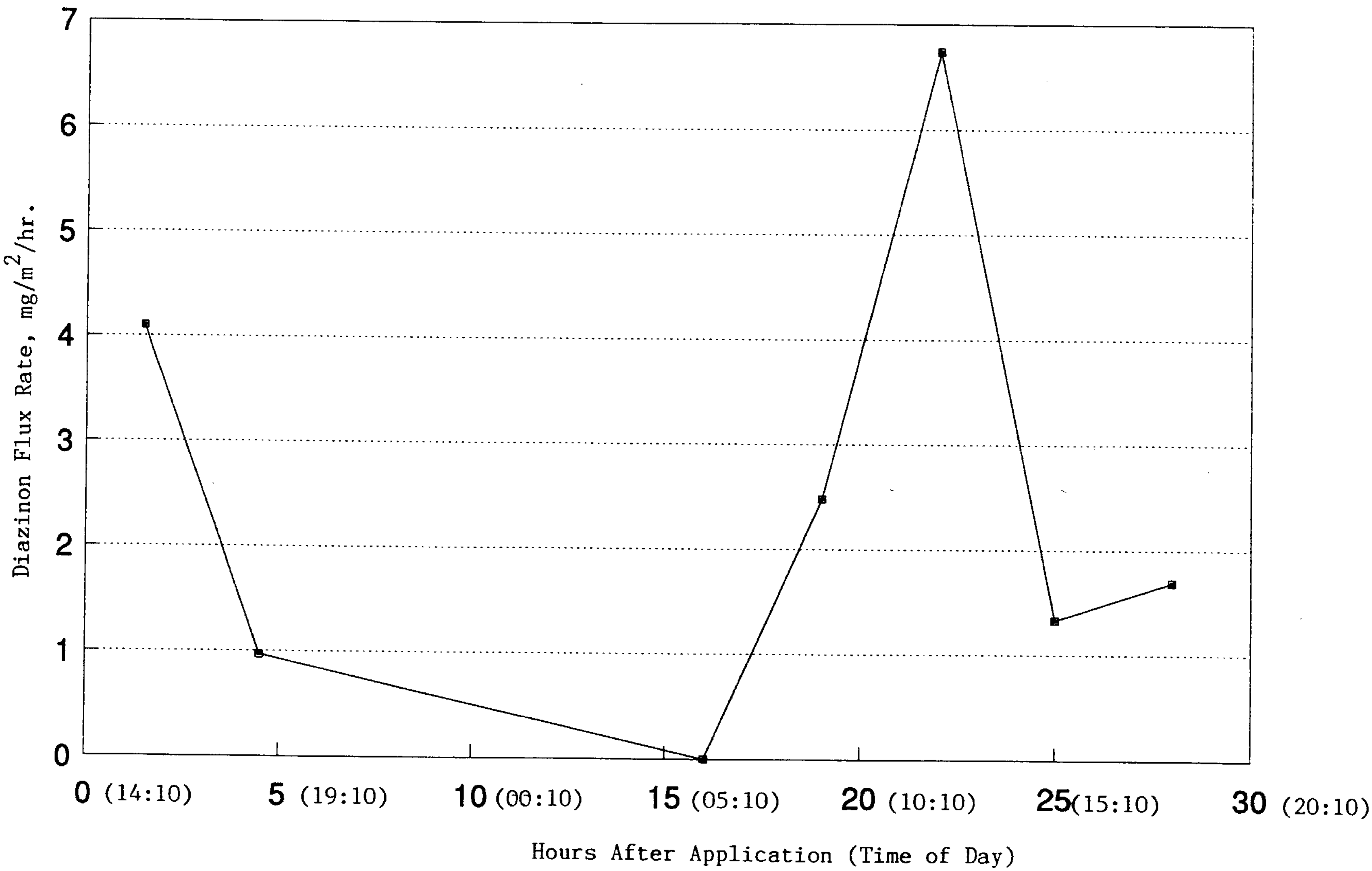
During the spring 1984 treatment the air concentration, wind speed, and temperature were measured after a liquid diazinon application. These measurements were used to estimate the air flux, or mass of diazinon volatilizing from treated areas. The air flux ranged from 0 to 6.74 $mg/m^2/hr$ and varied diurnally, with little or no volatilization at night and higher volatilization during the day (Figure 2). During the 29 hour and 40 minute period following application, a total of 57 mg/m^2 of diazinon volatilized, representing 9% of the 641 mg/m^2 applied. Ross and Sava (1986) found that molinate, which has similar volatility and was measured under similar conditions, lost 9% through volatilization on the day of treatment. These air flux values are larger than those measured in a microecosystem by Branham and Wehner (1985), where approximately 1% of diazinon was lost due to volatilization in the first week.

Table 13. Ranges of diazinon concentrations in air, Japanese Beetle Project, Sacramento, 1983-6.

		Diazinon Concentration Range, $\mu g/m^3$			
Treatment[a]	N	Background	Application and Watering	Post Application	24-hr Post Application
Spring 1984					
1st Application	4	0.02 - 0.13	5.3 - 32	8.9 - 19	Not Sampled
2nd Application	3	0.07 - 0.34	1.6 - 22	1.1 - 12	Not Sampled
Fall 1984					
1st Application	3	0.03 - 0.24	1.3 - 2.4	0.93 - 4.7	0.89 - 2.7
2nd Application	5	0.06 - 0.25	0.37 - 9.9	0.58 - 7.1	0.14 - 6.7
Spring 1985					
1st Application	3	0.03 - 0.30	0.42 - 7.5	0.65 - 2.0	1.2 - 1.8

a The Spring 1984 applications used liquid diazinon, all others used granular diazinon

Figure 2. Diazinon air flux following the second application at location 6, spring 1984, Japanese Beetle Project, Sacramento, 1983-86. The time period shown is from 3/24/84, 2:10 p.m. to 3/25/84, 8:10 p.m.



Fruit

Diazinon was detected and confirmed in one fig sample from one location and detected, but unconfirmed in one persimmon sample from a second location. Both the fig and persimmon samples contained 0.1 ppm of diazinon, which was below the 0.5 ppm tolerance level for figs; no tolerance exists for persimmons. The positive samples were collected during the fall 1984 treatment. All other samples for all treatments had no detectable concentrations of diazinon (detection limit 0.1 ppm). Included among the other samples were figs and persimmons from different locations and other fruit collected from the positive persimmon and fig locations. The positive fig site could not be sampled during later treatments because it did not bear fruit, and the positive persimmon site was not treated. Table 14 shows the number and types of fruit samples collected for all treatments.

Bartsch (1974) has summarized the occurrence of diazinon in agricultural products. Diazinon is only slightly translocated, and mainly found as metabolites. A hydrolysis breakdown product was found in peas, beans, spinach, rice and tomatoes. Traces of the oxygen analog have been found in pome fruits, vegetables, rice and olive oil.

Table 14. Sampling periods and number of sites for the diazinon fruit monitoring, Japanese Beetle Project, Sacramento, 1983-6. The data represent the totals for all treatments combined.

	Number of Properties Sampled	Sampling Period, Days After First Application	
		Preharvest	Harvest
Apples	5	11 - 17	26 - 28
Apricots	4	78 - 108	88 - 117
Berries	4	68 - 84	78 - 93
Cherries	5	51 - 60	59 - 72
Fava Beans	1	37	51
Figs	7[a]	13 - 23	28 - 36
Grapes	8	7 - 21	21 - 35
Grapefruit	4	32 - 110	100 - 134
Lemons	1	47	not sampled
Limes	1	25	48
Loquats	4	51 - 66	59 - 81
Oranges	9	43 - 72	55 - 126
Peaches	4	92 - 109	100 - 140
Pecans	2	32 - 33	77 - 78
Persimmons	4	32 - 50	55 - 89
Pomegranates	1	not sampled	55
Walnuts	4[a]	7 - 21	21 - 35

a One of the properties could not be resampled during the harvest interval.

Water

The quality control data indicated that the analyses were performed generally well. The mean recovery of spiked samples was 83%, with a standard deviation of 20. Of the six samples split between CAL and the CDFA laboratory, good agreement was obtained with five samples. Overall, the mean value for the six samples was 6.9 ppb for CAL and 6.2 for CDFA.

The background monitoring showed that diazinon was present in creeks prior to each of the last five treatments; no background samples were collected prior to the first treatment. The results of the background monitoring are summarized in Table 15, details for each treatment are given in the appendices. Background concentrations at individual sites varied from none detected to 6.2 ppb. The amount of diazinon leaving the area over time, or mass discharge rate, varied from zero to 2800 µg/sec. The highest background concentrations and discharges documented occurred prior to the spring 1984 treatment. These samples were collected during a rain storm on February 15, 1984. In contrast, all other background samples were collected during dry periods. Details of the February 15th sampling can be found in Appendix II. These background levels were most likely due to diazinon applications not associated with this project.

Irrigation runoff monitoring occurred during the fall 1984 treatment only. Water concentrations and flow rates were measured from seven sites twice a week during the six-week treatment period, and for a one-week period after treatment. The amount of diazinon discharged through irrigation runoff is

Table 15. Summary of diazinon concentrations in background water samples collected from creeks, Japanese Beetle Project, Sacramento, 1983-6. Locations of monitoring sites are shown in Figure 4. Because of changes in the treatment area with each season, site selection changed with each treatment.

Location	# of Samples	Diazinon Concentration, ppb		Diazinon Discharge, µg/sec	
		Max	Min	Max	Min
2	3	1.1	<0.1[a]	2800	0
6	4	1.6	<0.1	15	0
10	1	6.2	6.2	120	120
11	1	0.21	0.21	0.8	0.8
12	4	0.61	<0.1	6.1	0
13	1	4.9	4.9	98	98
14	2	<0.1	<0.1	0	0
15	2	1.5	0.70	23	5.2
16	2	5.9	<0.1	250	0
17	3	2.9	0.40	350	12

a "<" indicates none detected and the detection limit shown in Figure 3. The sampling showed a fairly constant amount of diazinon discharged during the first four weeks of the treatment. The variations during the last two weeks were mainly due to changes in water concentration. The average discharge rate during the study period was 2.6 grams of diazinon per hour, with a high of 7.8 g/hr and the total amount discharged was 3.1 kg. The total amount of diazinon applied during the fall 1984 treatment was 2730 kg, so approximately 0.11% of the applied diazinon entered waterways through irrigation runoff. More details are given in Appendix III.

Rain runoff monitoring occurred during the rainfall season for each treatment. The results of the monitoring are summarized in Table 16 and details are given in the appendices. A total of 15 rain storms were monitored; concentrations at individual sites ranged from none detected to 82 ppb and mass discharge rates varied from zero to 5100 µg/sec. By combining the discharges at the appropriate sites, the total mass discharge rates for the entire treatment area were calculated. The total mass discharge rate measured for each rainstorm monitored is shown in Table 17. Discharge rates were so variable because many factors such as amount of diazinon applied, time sampled, amount of rainfall, and location of monitoring sites influenced the rates. The highest rate found was 24 g/hr during one of the storms following the fall 1983 treatment. Even if the 24 g/hr rate continued for 10 days, the total amount discharged would still be less than one percent of the 648 kg applied during 1983.

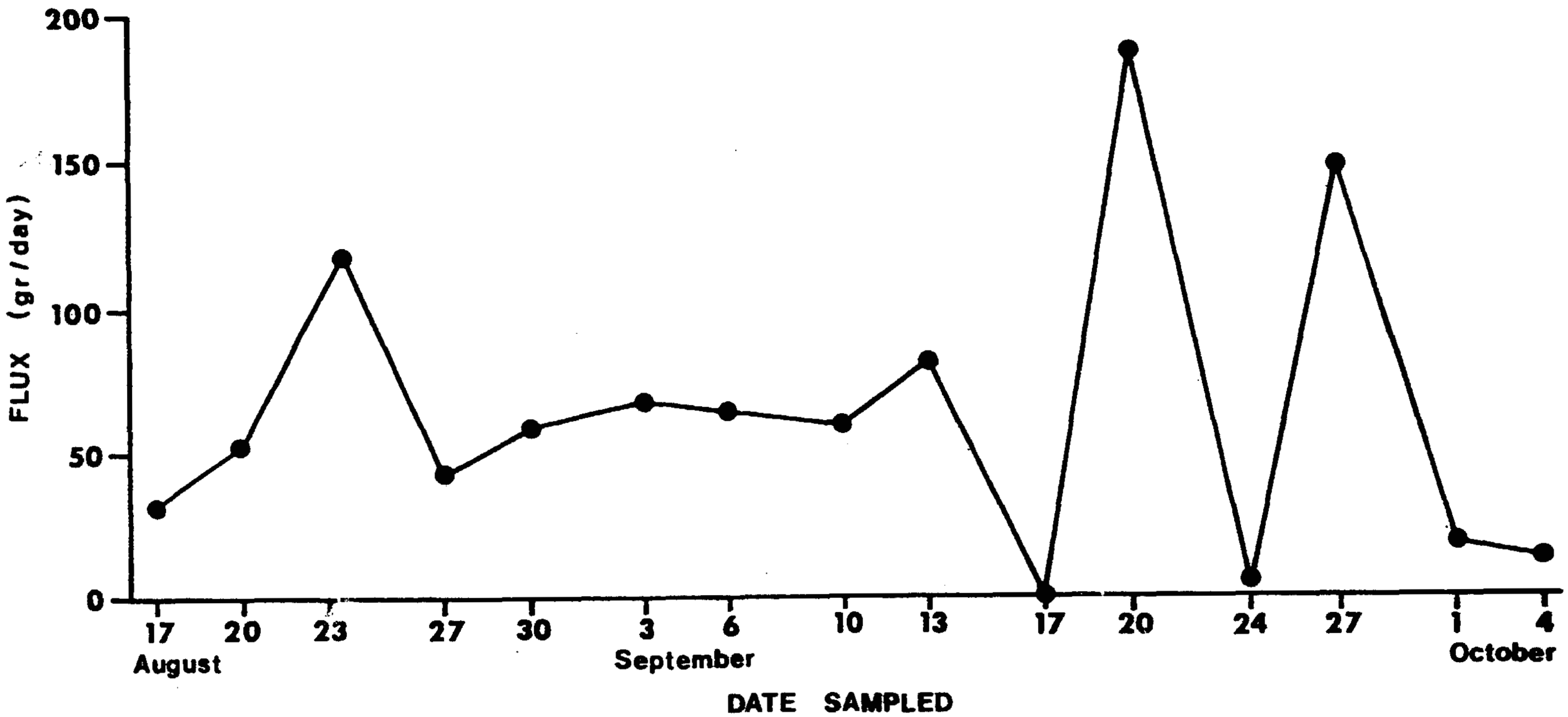


Figure 3. Diazinon irrigation runoff from the Japanese beetle treatment area, Fall 1984. The graph shows the total amount of diazinon leaving the treatment area via waterways.

Table 16. Summary of diazinon concentrations in rain runoff samples, Japanese Beetle Project, Sacramento, 1983-6. Locations of monitoring sites are shown in Figure 4. Because of changes in the treatment area with each season, site selection changed with each treatment.

		Diazinon Concentration, ppb		Diazinon Discharge, µg/sec	
Site	N	Max	Min	Max	Min
1	5	3.5	<0.1[a]	710	0
2	8	7.0	<0.1	680	0
3	2	24	<0.1	0	0
4	2	2.8	<0.1	560	0
5	3	44	<0.1	2500	0
6	11	34	<0.1	5100	0
7	2	2.1	1.0	88	3.1
8	3	1.0	<1.0	27	0
9	3	1.0	0.40	21	0.50
10	2	82	23	330	23
11	2	11	5.2	310	110
12	7	1.0	<0.1	61	0
13	2	56	51	2000	110
14	3	35	0.1	2100	unknown[b]
15	3	2.5	1.9	200	unknown
16	3	3.9	1.2	310	unknown
17	6	27	0.40	5100	unknown

a "<" indicates none detected and the detection limit

b The discharge rate is unknown when the flow rate could not be measured

Figure 4. Diazinon water sampling locations, Japanese Beetle Project, Sacramento 1983-86.

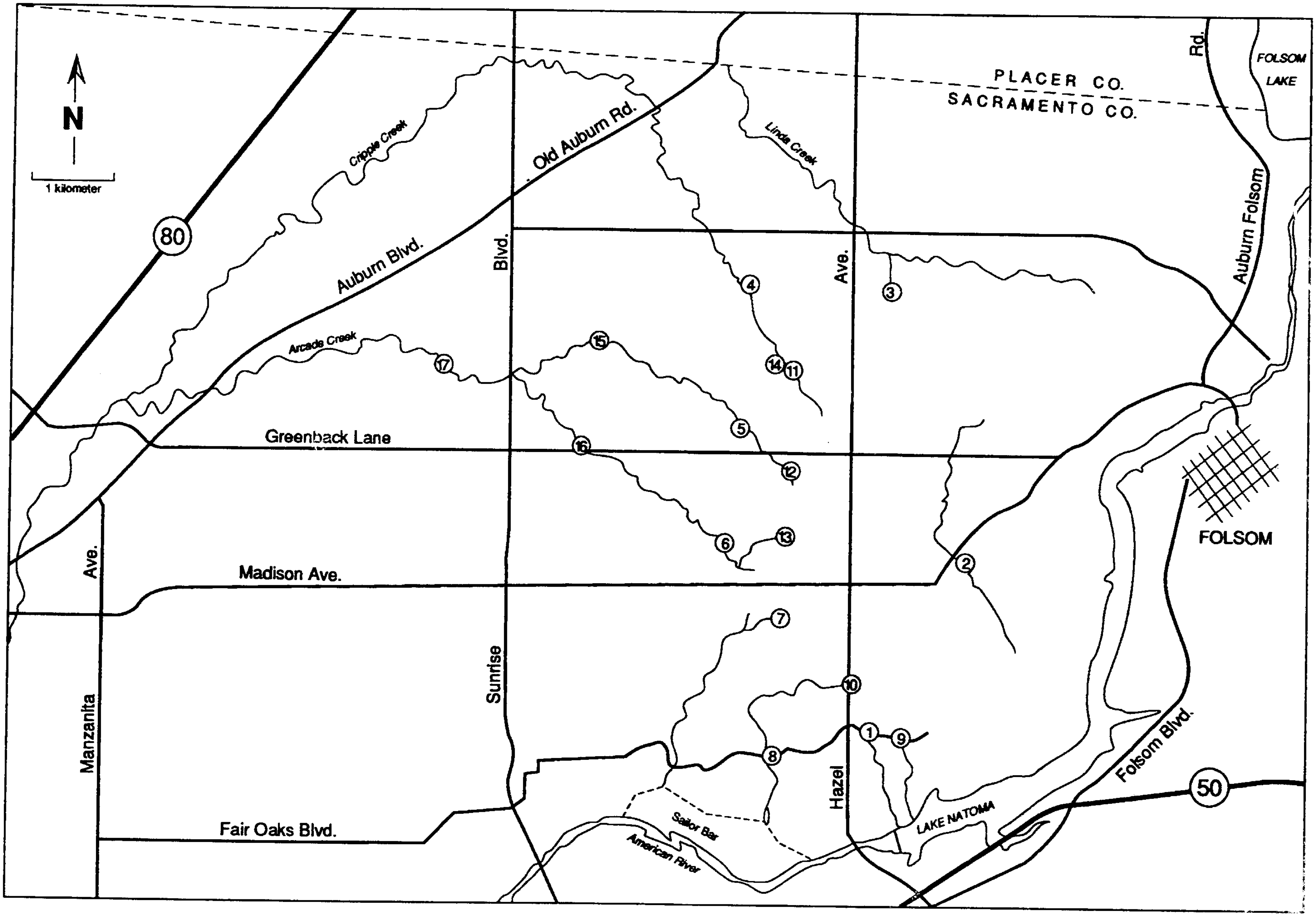


Table 17. Total diazinon mass discharge rates for monitored rain storms, Japanese Beetle Project, Sacramento, 1983-6. Treatment periods are shown in parentheses.

Rain Storm	Diazinon Discharge, g/hr	Rainfall, cm
Fall 1983 (9/6-10/18)		
9/30/83	not measured	1.20
10/29/83	not measured	0.84
11/9/83	0.83	0.71
11/10/83	24	4.20
12/23/83	not measured	0.81
Spring 1984 (3/1-4/30)		
3/13/84	0.87	0.56
4/10/84	15	0.56
Fall 1984 (8/20-10/3)		
8/30/84	>18[a]	0.25
10/16/84	12	1.70
11/7/84	not measured	1.65
Spring 1985 (3/1-5/2)		
3/26/85	>21	2.16
Fall 1985 (8/19-10/2)		
9/8/85	>0.19	0.28
9/17/85	0.79	not measured
Spring 1986 (3/3-4/21)		
3/7/86	0.18	0.58
4/5/86	2.0	0.38

a ">" - Due to descrepancies in the data an exact estimate of the discharge rate could not be made

The mass of diazinon discharged through all runoff was low when compared to the amount applied. However, some of the concentrations were relatively high because the low water flow rates caused little dilution. This phenomenon has been seen before, where large urban areas have been treated with pesticides and runoff from these areas have high pesticide concentrations (Oshima, 1982). Leistra, et al (1984) also found up to 21 ppb diazinon in 9 of 22 samples collected from watercourses which contained irrigation runoff from glasshouses (greenhouses).

Two series of river samples collected by the California Department of Fish and Game showed no detectable concentration of diazinon.

Ground water samples were collected from the one well within the treatment area. However, the well property itself did not have any turf and was not treated. None of the four samples collected contained a detectable amount of diazinon.

CONCLUSIONS AND RECOMMENDATIONS

As with isofenphos, the true concentrations and dissipation rates of diazinon were difficult to estimate because of the high inherent variation. Each granule contained a significant proportion of the diazinon in an individual sample. Therefore, even small variations in application created large variations in sample concentrations. In order to achieve better estimates of diazinon concentration the application variability must be decreased and/or a greater number of samples must be collected.

Even though exact concentrations were difficult to determine, some general trends were observed. Nondetectable levels in turf/thatch and surface soil were found two to three weeks after application, as opposed to isofenphos which did not have nondetectable levels until 20 to 30 weeks after application. Within each diazinon treatment, no accumulation of residues from the first to the third application were observed. In addition, all background samples collected prior to each treatment contained no diazinon, indicating that there was no carryover from season to season.

Off-target movement was minimal, but in some cases greater than isofenphos. For instance, volatilization of diazinon was significantly higher than isofenphos. Air concentrations were 100 to 1000 times higher, and although the air flux of isofenphos was not measured it was undoubtedly lower than the 57 mg/m^2 (9% of application rate) measured for diazinon. In addition, detectable levels of diazinon in fruit were found in at least one instance, while no isofenphos was detected in any fruit sample. On the other hand, diazinon losses by surface runoff were lower than isofenphos. The highest diazinon discharge rate, 24 g/hr, was lower than the highest isofenphos discharge rate, 31 g/hr, even though a much greater amount of diazinon was applied. Downward movement through soil was minimal for both chemicals, with the majority of the 0-15 and 15-30 cm core samples containing no detectable diazinon.

Wildlife impacts due to the diazinon treatments appear to be greater than isofenphos. Nine confirmed bird kills due to diazinon poisoning were documented by the CDFA Animal Health Branch, while none were attributed to isofenphos (personal communication from Dennis Thompson to Peter Kurtz, 8/2/84). Bird kills attributed to diazinon poisoning have occurred before, and led to the cancellation of diazinon for golf courses and sod farms in 1988 (USEPA, 1988).

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APPENDIX I

FALL 1983 DIAZINON TREATMENT

INTRODUCTION

Diazinon was applied only to irrigated pasture areas during the fall 1983 treatment. Three applications were made with granular diazinon, Dzn 14G®, to pastures within the boundaries shown in Figure I-1. A total of 648 kg of diazinon was applied between September 6 and October 18, 1983.

Diazinon concentrations were monitored in turf/thatch, soil, fruit and water. Three locations were monitored for diazinon in turf/thatch and soil. Most of the turf/thatch and soil samples were collected just before and just after each application. One site (Location 22) was also monitored for dissipation over time. Turf and thatch were combined into one sample and analyzed for total (dislodgable + internal) residue. Soil was collected from the 0-15 cm depth. Fruit samples were collected from two locations, one apple and one grapefruit. Rain runoff samples were collected during the first five rain storms. In addition, the California Department of Fish and Game collected water samples from the American River at the Nimbus Fish Hatchery, Sunrise Bridge and Sailor Bar.

RESULTS AND DISCUSSION

Turf/Thatch

Location 36 was originally scheduled to be sampled every four days between applications and every four days for 20 days following the final application. Locations 22 and 33 were to be sampled just before and after each application. However, permission to sample was revoked for Location 36 after the second application, so dissipation samples were collected from Location 22.

Turf/thatch residues were the highest documented during the entire treatment program, with concentrations on Day 0 varying from 360 to 1700 mg/m^2 (Table I-1). Several sampling periods showed mean concentrations above the 641 mg/m^2 application rate, but the variation was high so the means may not be accurate. Another complicating factor was the sampling schedule. This treatment's samples were collected on 0, 4, 8, and 12 days after application, while other treatments were sampled on 1, 5, 9, and 13 days after treatment. Therefore, comparison of this treatment to others is difficult and may be part of the reason for the higher concentrations. The change in sampling locations as well as the variability makes it very difficult to determine any dissipation trends.

Soil

Soil concentrations were fairly typical, varying from nondetectable to 2.1 ppm (Table I-2). Again the change in sampling locations and differences in sampling schedules makes it difficult to make generalizations. Some of the high variability for both soil and turf/thatch was probably due to uncertainty during the early part of the program. The fall 1983 treatment was the first application of this type for the Japanese Beetle Project personnel, the first time these types of samples were collected by the EHAP, and the first time these types of samples were analyzed by the laboratory.

Fruit

Only two fruit trees could be found within treated pasture areas. None of the samples collected contained a detectable amount of diazinon (detection limit 0.1 ppm). Apples were collected 11 and 28 days after the first application and grapefruit were collected 86 and 100 days after the first application.

Water

Results of the rain runoff monitoring are given in Table I-3. The concentrations varied from none detected to 44 ppb and mass discharge rates varied from 0 to 2900 µg/sec. All nine waterways draining the treatment area were sampled on November 9 and 10, 1983. The combined discharge rate from these nine creeks was 230 µg/sec on the 9th and 6800 µg/sec on the 10th, or 0.83 g/hr and 24 g/hr. In comparison, the discharges for isofenphos on the same dates were 0.63 and 13 g/hr.

The CDFG monitoring of the American River showed no detectable concentrations on October 5, November 2, and November 15, 1983 (detection limit 1.0 ppb).

Figure I-1. Diazinon treatment areas, fall 1983. Numbered locations indicate water sampling sites.

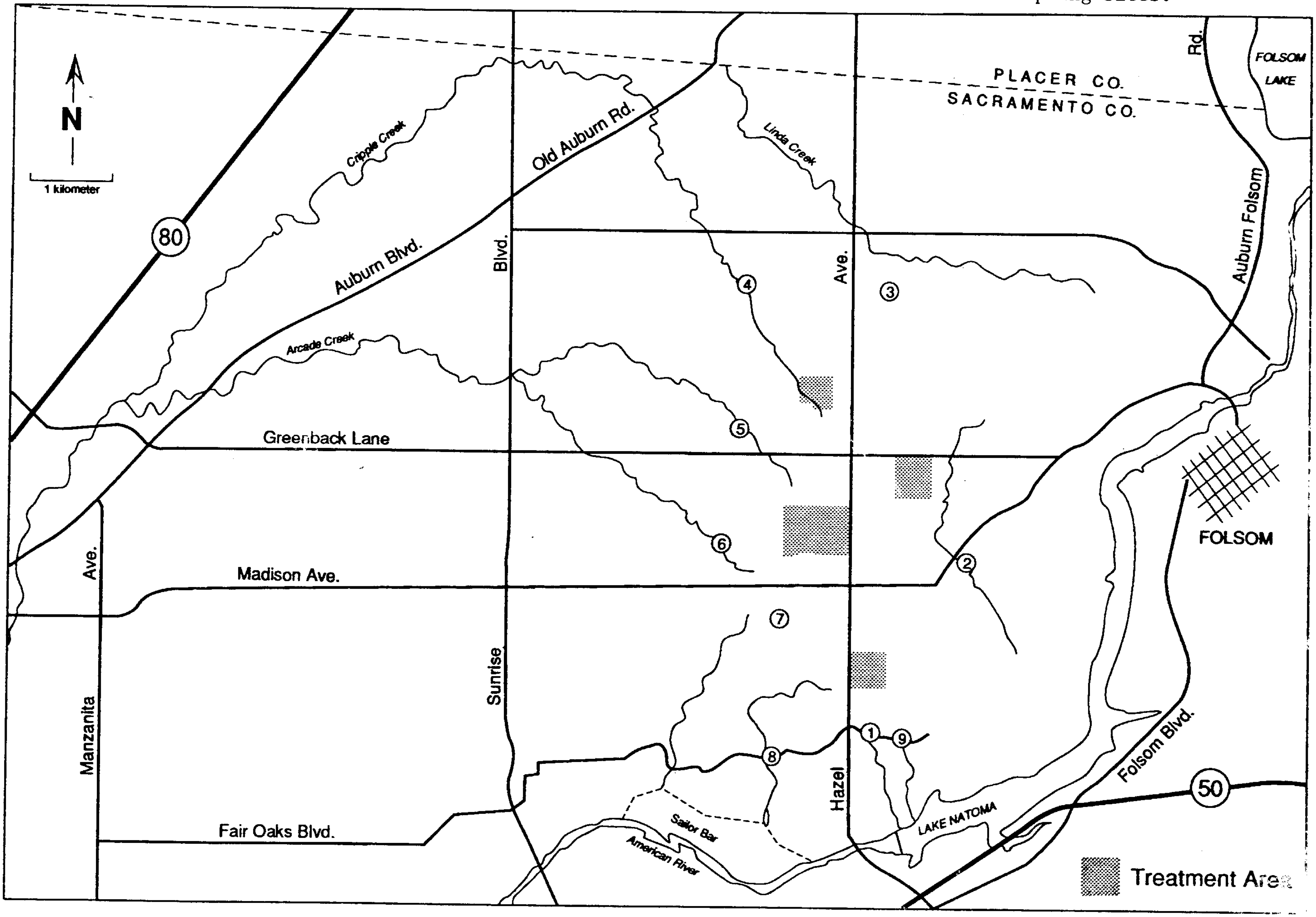


Table I-1. Results for total (dislodgable + internal) diazinon concentrations in turf/thatch, fall 1983, Japanese Beetle Project, Sacramento, 1983-6. Each mean is calculated from three replicate samples. Values below the detection limit are calculated as 1/2 the detection limit.

	Diazinon Concentration, mg/m^2					
	Location 22		Location 33		Location 36	
Sampling Day	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
Application 1						
Background	ND[a]	-----	ND	-----	ND	-----
0	430	135	samples lost		1700	700
4	not sampled		not sampled		200	12
8	not sampled		110	31	710	330
11	340	250	84	7.0	not sampled	
12	not sampled		not sampled		ND	-----
Application 2						
0	470	37	550	110	750	350
4	250	89	not sampled		not sampled	
8	250	74	not sampled		not sampled	
9	not sampled		28	4.0	not sampled	
10	1000	330	not sampled		not sampled	
Application 3						
0	820	230	360	160	not sampled	
7	53	25	not sampled		not sampled	
12	91	46	not sampled		not sampled	
16	2.8	0.62	not sampled		not sampled	
20	29	24	not sampled		not sampled	

a ND - None Detected, with a detection limit a detection limit of approximately 2 mg/m^2.

Table I-2. Results for diazinon concentrations in soil (0-15 cm, ppm), fall 1983, Japanese Beetle Project, Sacramento, 1983-6. Each mean is calculated from three replicate samples. Values below the detection limit are calculated as 1/2 the detection limit.

	Diazinon Concentration, ppm					
	Location 22		Location 33		Location 36	
Sampling Day	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
Application 1						
Background	not sampled		not sampled		ND (0.05)[a]	-----
0	not sampled		not sampled		0.70	0.15
4	not sampled		not sampled		0.66	0.17
8	not sampled		0.47	0.13	0.66	0.42
11	not sampled		0.07	0.02	not sampled	
12	not sampled		not sampled		ND (0.05)	-----
Application 2						
0	not sampled		0.64	0.15	2.1	0.49
4	0.44	0.33	not sampled		not sampled	
8	1.3	0.53	not sampled		not sampled	
9	not sampled		ND (0.05)	-----	not sampled	
10	0.59	0.18	not sampled		not sampled	
Application 3						
0	0.52	0.24	0.22	0.17	not sampled	
7	0.19	0.10	not sampled		not sampled	
12	0.54	0.28	not sampled		not sampled	
16	ND (0.05)	-----	not sampled		not sampled	
20	ND (0.05)	-----	not sampled		not sampled	

a ND - None Detected, with the value indicating 1/2 the detection limit

Table I-3. Results of the diazinon rain runoff monitoring, fall 1983, Japanese Beetle Project, Sacaramento, 1983-6. Sampling locations are shown in Figure I-1.

Site	Diazinon Concentration, ppb (Diazinon Discharge, µg/sec)				
	Date: 9/30/83[a]	10/29/83[a]	11/9/83	11/10/83	12/23/83
	Rainfall: 1.2 cm	0.84 cm	0.71 cm	4.2 cm	0.81 cm
1	<1.0[b]	<1.0	<1.0 (0)	3.5 (130)	3.1 (710)
2	7.0	broken	<1.0 (0)	1.4 (630)	not sampled
3	not sampled	broken	<1.0 (0)	24 (0)	not sampled
4	not sampled	broken	<1.0 (0)	2.8 (560)	not sampled
5	not sampled	<1.0	4.0 (56)	44 (2500)	not sampled
6	not sampled	<1.0	1.7 (170)	2.9 (2900)	not sampled
7	not sampled	broken	1.0 (3)	2.1 (88)	not sampled
8	not sampled	<1.0	<1.0 (0)	0.8 (27)	not sampled
9	not sampled	broken	1.0 (1)	0.4 (1)	0.5 (21)

a Samples collected on 9/30 and 10/29 were collected at night, water flow could not be measured.

b "<" indicates no detectable concentration and the detection limit.

APPENDIX II

SPRING 1984 DIAZINON TREATMENT

INTRODUCTION

The treatment area was reduced for the spring 1984 applications; only those properties within a 200 m radius of a 1983 Japanese beetle find were treated (Figure II-1). Starting with the spring 1984 treatment diazinon was the only soil pesticide used, isofenphos was discontinued. An emulsifiable concentrate of diazinon, Dzn AG500®, was applied to turf areas and the granular Dzn 14G® was applied to pastures. The Dzn AG500® was mixed with water to a working concentration of 0.30% for residential properties and 2.15% for schools. A total of 618 kg of diazinon was applied for this treatment between March 1 and April 30, 1984.

Diazinon concentrations were monitored in turf/thatch, soil, air and water. Turf/thatch, soil and air were monitored at three to five locations for the liquid diazinon applications. One location was monitored for turf/thatch and soil residue from granular applications. Most of the sampling took place just after each application. One liquid (Location 06) and one granular (Location 33) site were also sampled on 4, 8, 12, 16, and 20 days following the final application. Turf and thatch were combined into one sample and analyzed for total residue. Soil samples were collected from the 0-15 and 15-30 cm depths on the same schedule as the turf/thatch monitoring. A special series of measurements of the air concentration, wind speed and temperature were used to estimate the air flux, or mass of diazinon volatilizing from treated areas. Rain runoff was sampled during the first three rain storms. Additional samples of the tank mixture were collected just prior to each application at each monitored location.

RESULTS AND DISCUSSION

Tank

The target tank concentrations were 0.30 and 2.15% by weight. The 0.30% concentration was used for residential areas and 2.15% for large turf areas such as schools. Tank concentrations ranged from 70 to 124% and averaged 92.5% of the theoretical amount (0.30 or 2.15%).

Turf/Thatch

Turf/thatch concentrations were the lowest documented for all treatments, with concentrations ranging from 0.54 to 160 mg/m^2 (Table II-1, Figures II-2 and II-3). This was true for both the emulsifiable concentrate and granular sites.

Soil

Soil concentrations were also the lowest documented for all treatments (Tables II-2 and II-3, Figures II-4, II-5, II-6). Concentrations at the 0-15 cm depth ranged from 0.01 to 0.53 ppm and 0.01 to 0.07 ppm at the 15-30 cm depth. This was true for both the emulsifiable concentrate and granular sites.

One of the factors contributing to the low concentrations from the liquid applications was greater loss of diazinon to the air. Concentrations in air were the highest documented for the entire program (see Air Results and Discussion).

<u>Air</u>

Results of the normal residential and school monitoring are shown in Figures II-7 and II-8. These air concentrations were the highest found during any of the Japanese beetle treatments. The high concentrations were probably due to the different formulation. The emulsifiable concentrate used was probably more volatile and had a much greater potential for drift than the granular formulation normally used. The concentration range for the liquid formulation was 1.61 to 32.3 $\mu g/m^3$ and 0.37 to 9.9 $\mu g/m^3$ for the granular applications, during the application and watering periods for all treatments. Lower concentrations were observed for the second liquid application when nozzles creating larger droplets were used; larger droplets have less drift and evaporation.

The air flux ranged from 0 to 6.74 $mg/m^2/hr$ and varied diurnally, with little or no volatilization at night and higher volatilization during the day (Table II-4 and Figure II-9). During the 29 hour and 40 minute period following application a total of 57 mg/m^2 of diazinon volatilized, representing 9% of the 641 mg/m^2 applied.

Water

Results of the rain runoff monitoring are given in Table II-5. Concentrations for this treatment ranged from none detected to 82 ppb, while the discharge rates ranged from 0 to 2000 μg/sec. Total mass discharged ranged from 243 to 4140 μg/sec, or 0.88 to 15 g/hr. This was the only treatment for which background samples were collected during a rain runoff period. Background samples for all other treatments were collected during dry periods. As expected, the background concentrations and the background discharge rates were the highest measured for any treatment. In fact, the background discharge rate at site 2 was higher than the post application discharge rate.

Figure II-1. Diazinon treatment areas, spring 1984. Numbered locations indicate water sampling sites.

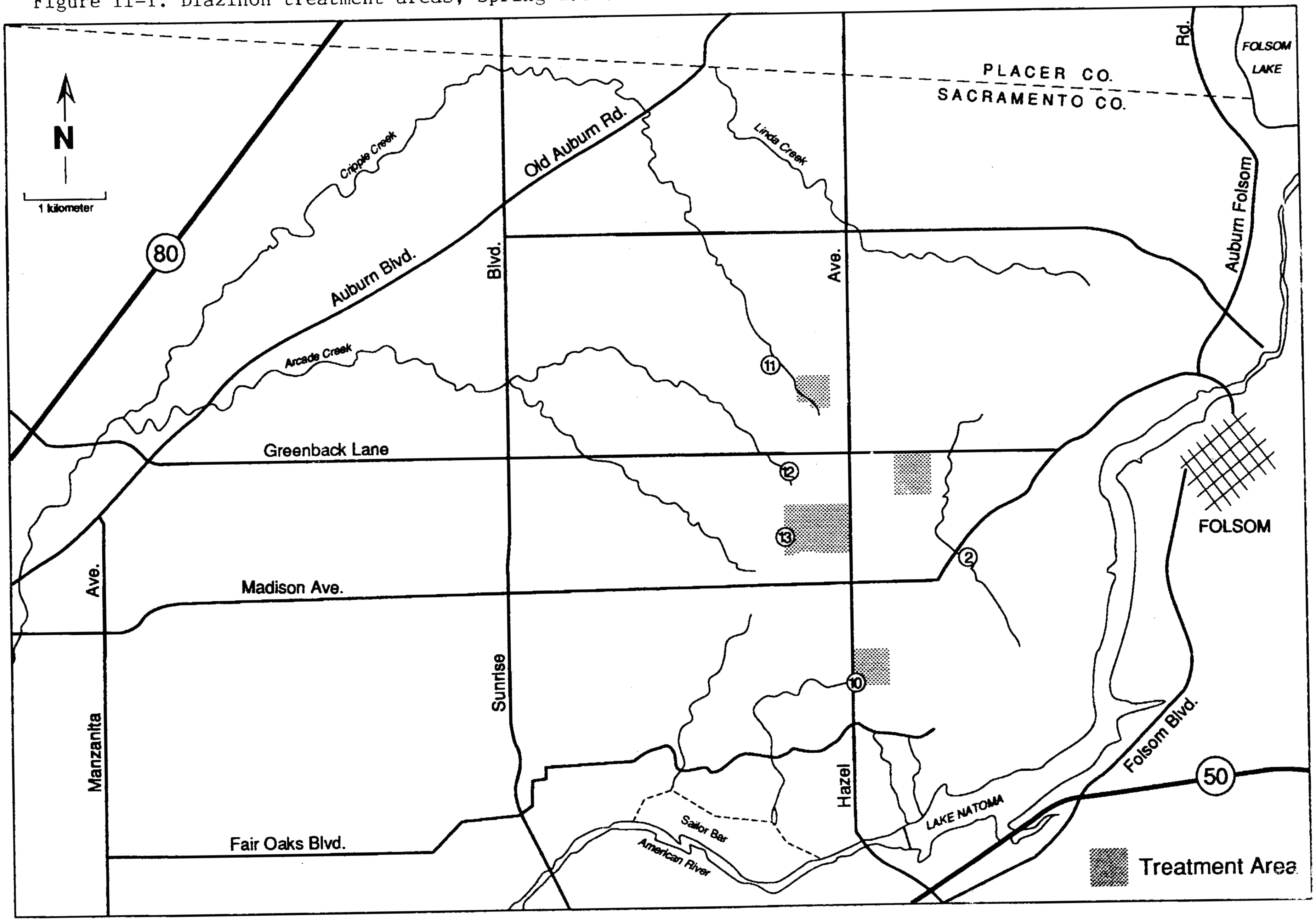


Table II-1. Results for total (dislodgable + internal) diazinon concentrations in turf/thatch, spring 1984, Japanese Beetle Project, Sacramento, 1983-6. Each mean is calculated from three replicate samples. Values below the detection limit are calculated as 1/2 the detection limit.

	Emulsifiable Concentrate Diazinon, mg/m^2						Granular Diazinon, mg/m^2	
	Location 01		Location 06		Location 33		Location 33	
Sampling Day	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
Application 1								
Background	ND[a]	----	ND	----	not sampled		ND	----
0	160	14	59	29	77	15	80	16
24	10	5.5	not sampled		3.4	1.3	not sampled	
Application 2								
0	69	7.6	77	25	43	11	33	16
15	45	18	not sampled		12	7.7	not sampled	
Application 3								
0	75	35	120	50	70	12	25	6.9
4	62	16	26	18	not sampled		22	8.9
8	35	11	14	3.3	not sampled		ND	---
12	not sampled		14	2.2	not sampled		ND	---
16	not sampled		6.8	6.0	not sampled		ND	---
20	not sampled		0.54	0.06	not sampled		ND	---

a ND - None Detected, with a detection limit of approximately 2 mg/m^2.

Figure II-2. Liquid Diazinon in Turf/Thatch Samples
Spring 1984.

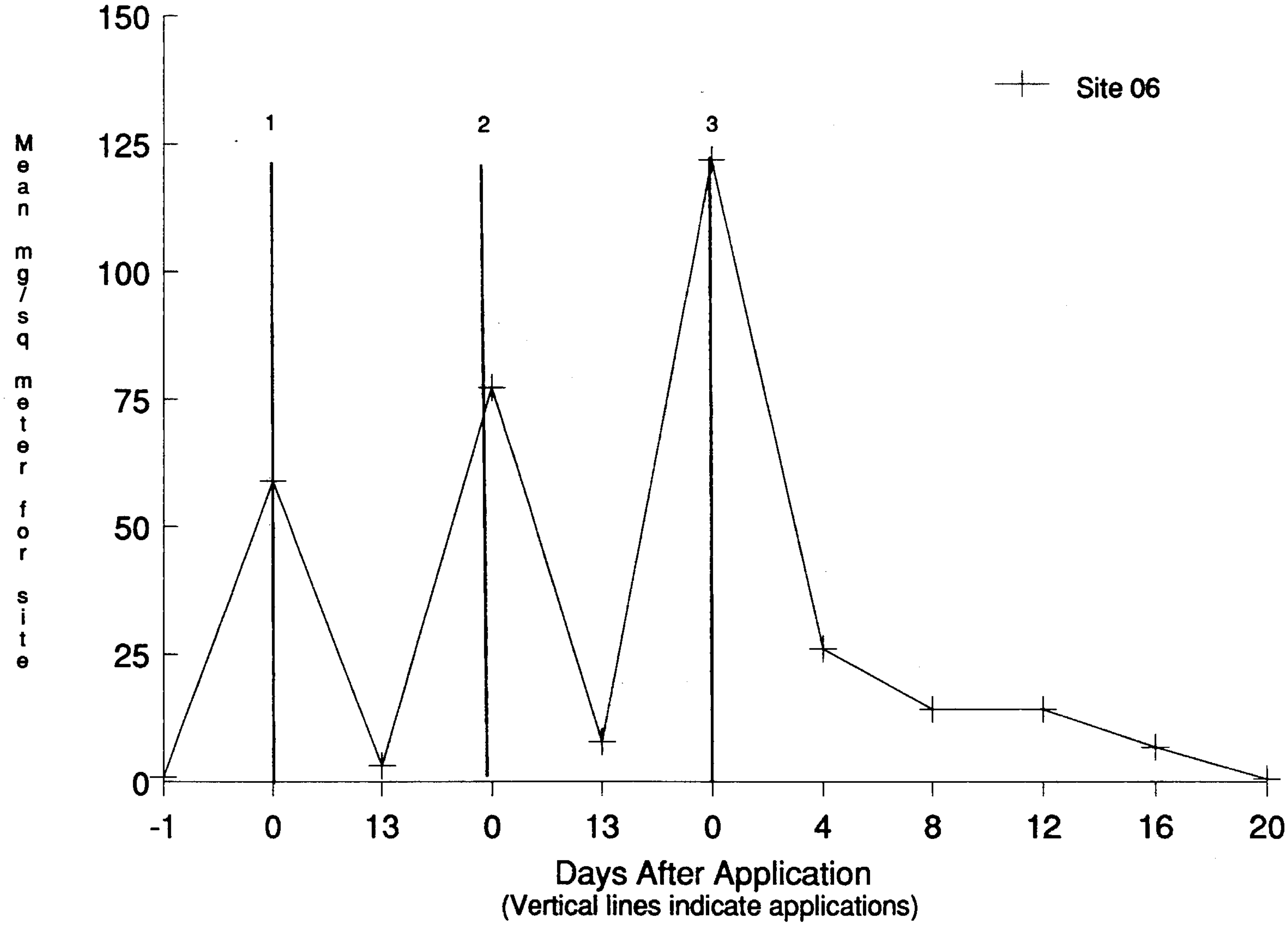


Figure II-3. Granular Diazinon in Turf/Thatch Samples
Spring 1984.

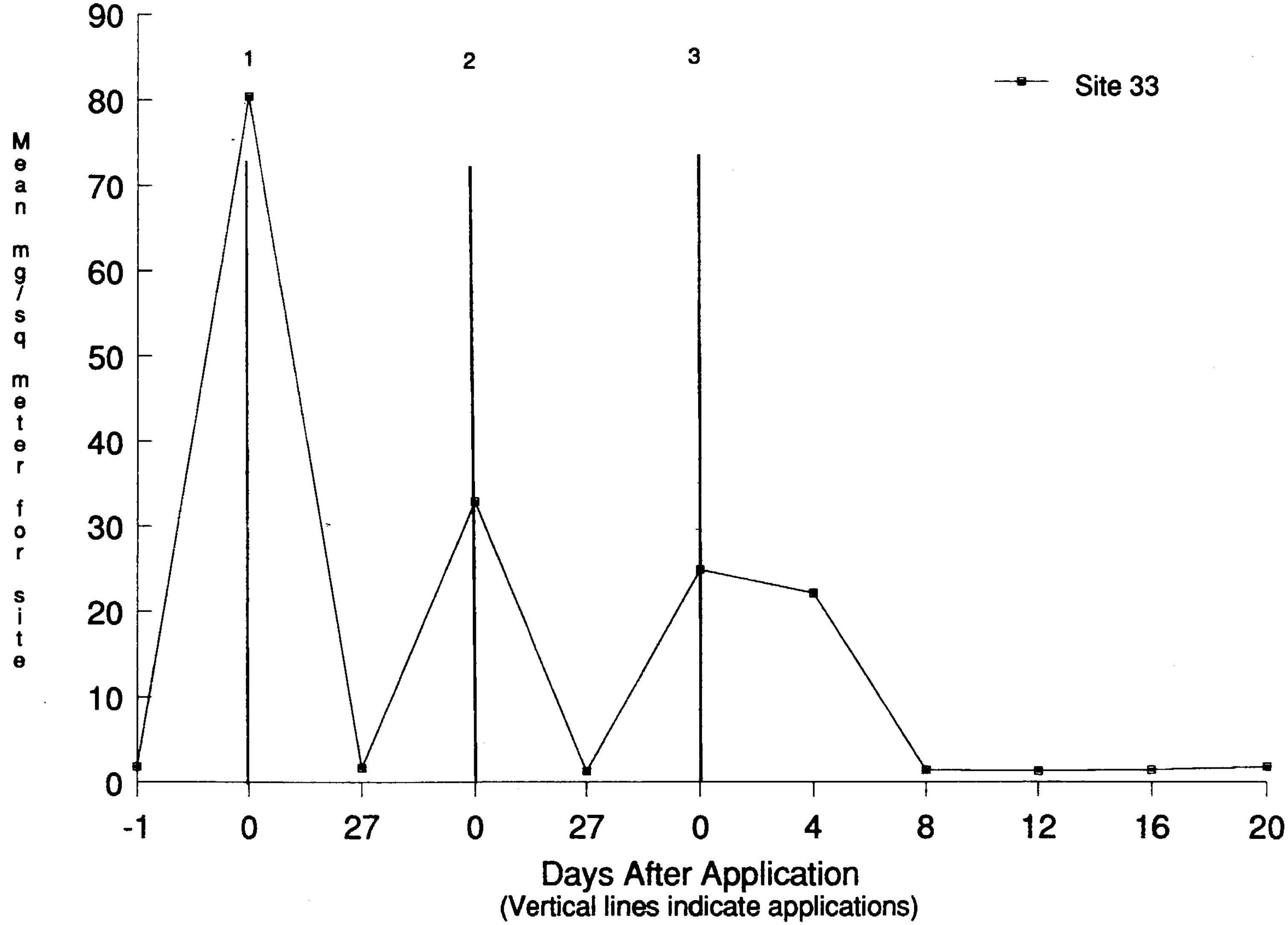


Table II-2. Results for diazinon concentrations in soil (0-15 cm, ppm), spring 1984, Japanese Beetle Project, Sacramento, 1983-6. Each mean is calculated from three replicate samples. Values below the detection limit are calculated as 1/2 the detection limit.

	Emulsifiable Concentrate Diazinon, ppm						Granular Diazinon, ppm	
	Location 01		Location 06		Location 33		Location 33	
Sampling Day	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
Application 1								
Background	ND (0.05)[a]	-----	ND (0.05)	-----	ND (0.05)	-----	ND (0.05)	-----
0	0.32	0.15	0.14	0.08	0.19	0.05	0.53	0.29
24	0.07	0.04	not sampled		0.07	0.05	not sampled	
Application 2								
0	0.08	0.03	0.04	0.01	0.21	0.13	ND (0.05)	-----
15	0.02	0.01	not sampled		0.09	0.03	not sampled	
Application 3								
0	0.16	0.10	0.10	0.03	0.07	0.04	ND (0.05)	-----
4	0.13	0.02	0.11	0.02	not sampled		0.07	0.02
8	0.31	0.08	0.13	0.03	not sampled		ND (0.05)	-----
12	not sampled		0.11	0.05	not sampled		ND (0.05)	-----
16	not sampled		0.02	0.01	not sampled		ND (0.05)	-----
20	not sampled		0.01	0.01	not sampled		ND (0.05)	-----

a ND - None Detected, with the value indicating 1/2 the detection limit

Figure II-4. Liquid Diazinon in Soil Samples (0-15 cm)
Spring 1984.

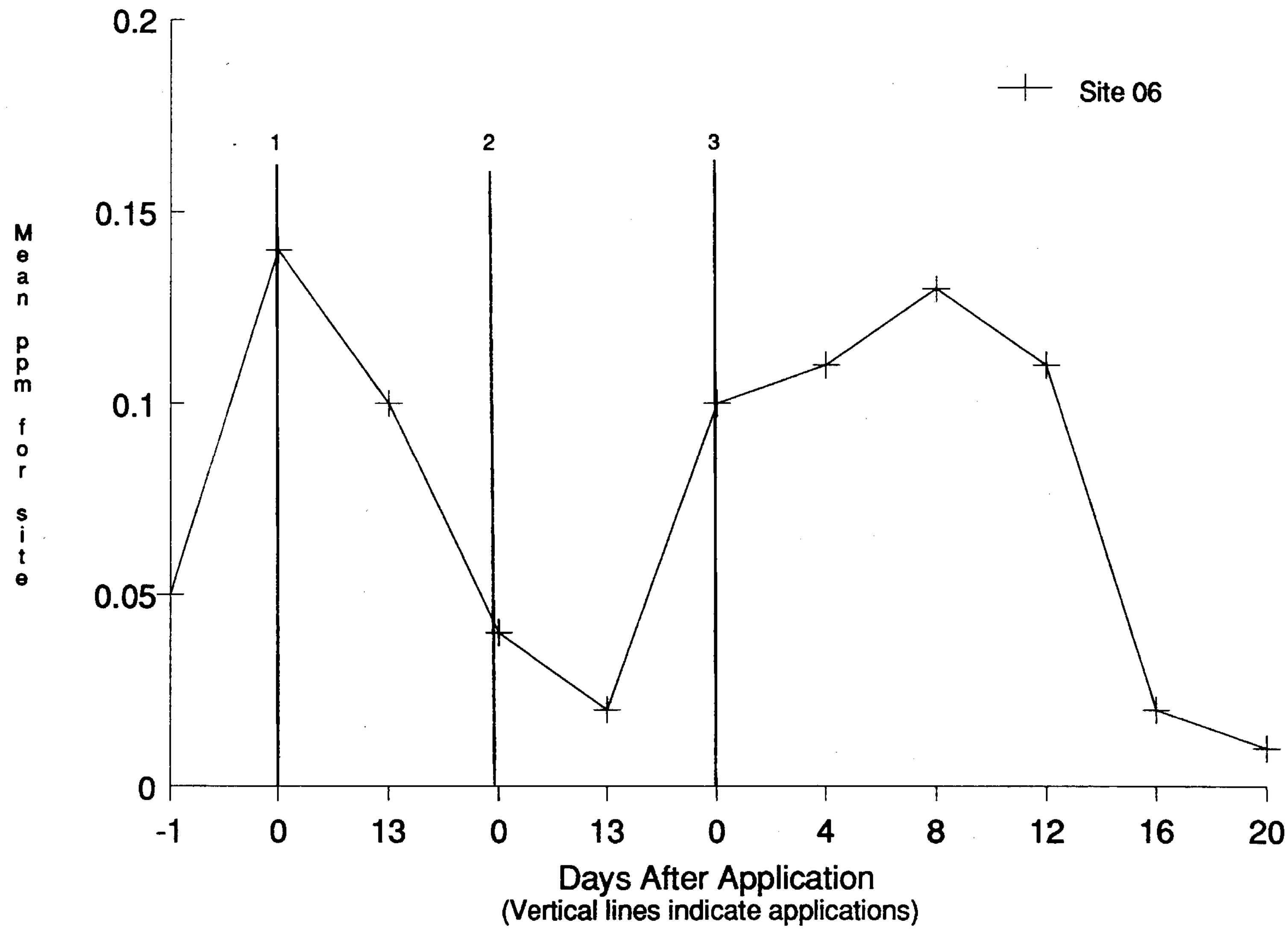


Figure II-5. Granular Diazinon in Soil Samples (0-15 cm)
Spring 1984.

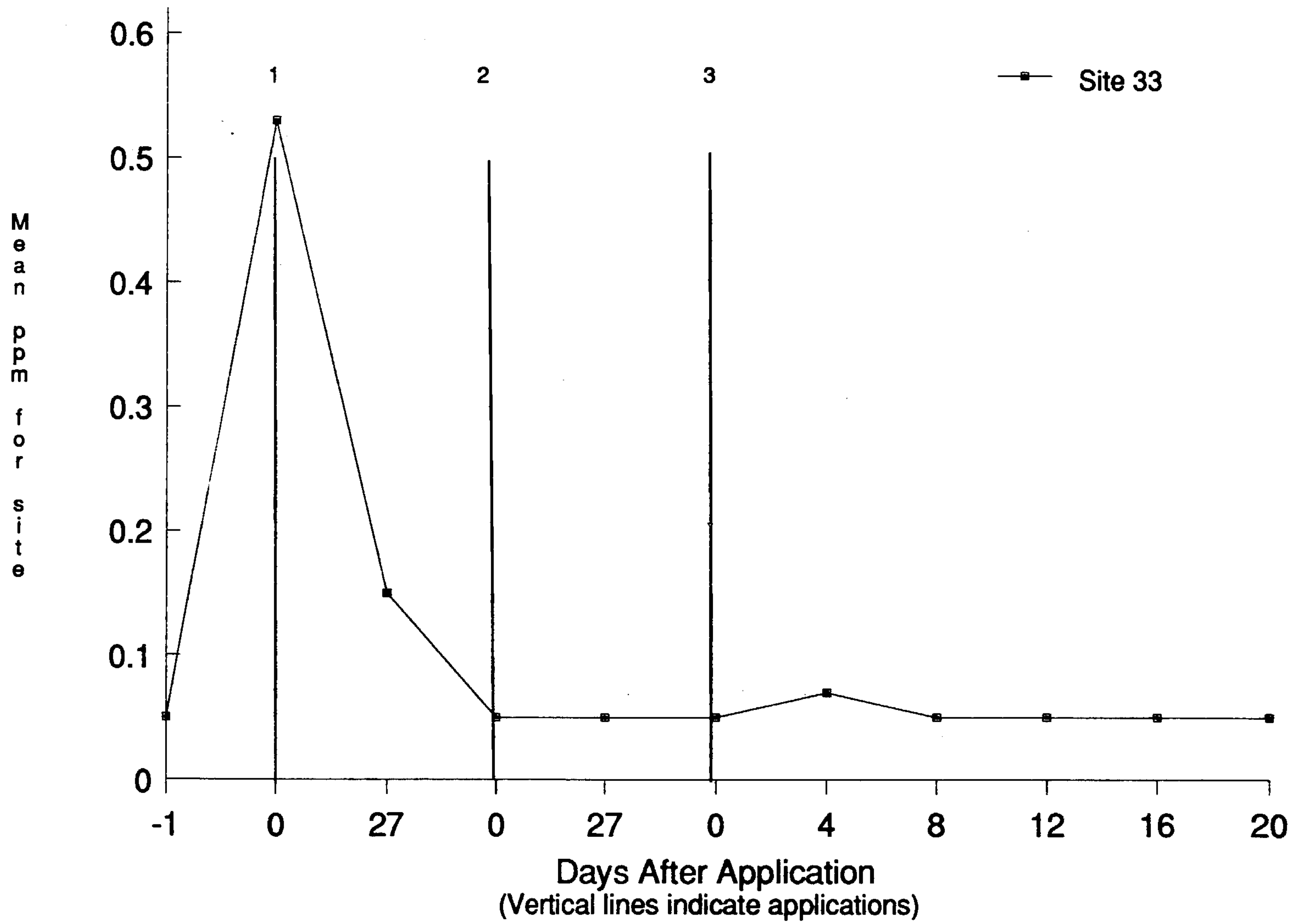


Table II-3. Results for diazinon concentrations in soil (15-30 cm, ppm), spring 1984, Japanese Beetle Project, Sacramento, 1983-6. Each mean is calculated from three replicate samples. Values below the detection limit are calculated as 1/2 the detection limit.

	Emulsifiable Concentrate Diazinon, ppm						Granular Diazinon, ppm	
	Location 01		Location 06		Location 33		Location 33	
Sampling Day	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
Application 1								
Background	ND (0.05)[a]	-----	ND (0.05)	-----	ND (0.05)	-----	ND (0.05)	-----
0	0.04	0.02	0.04	0.01	0.07	0.05	ND (0.05)	-----
24	0.01	0.01	not sampled		0.02	0.01	not sampled	
Application 2								
0	0.07	0.05	0.04	0.03	0.02	0.01	ND (0.05)	-----
15	0.01	0.01	not sampled		ND (0.05)	-----	not sampled	
Application 3								
0	ND (0.02)	-----	ND (0.01)	-----	0.04	0.03	not sampled	
4	0.02	0.01	0.05	0.03	not sampled		not sampled	
8	not sampled		0.04	0.02	not sampled		not sampled	

a ND - None Detected, with the value indicating 1/2 the detection limit

Figure II-6. Liquid Diazinon in Soil Samples (15-30 cm)
Spring 1984.

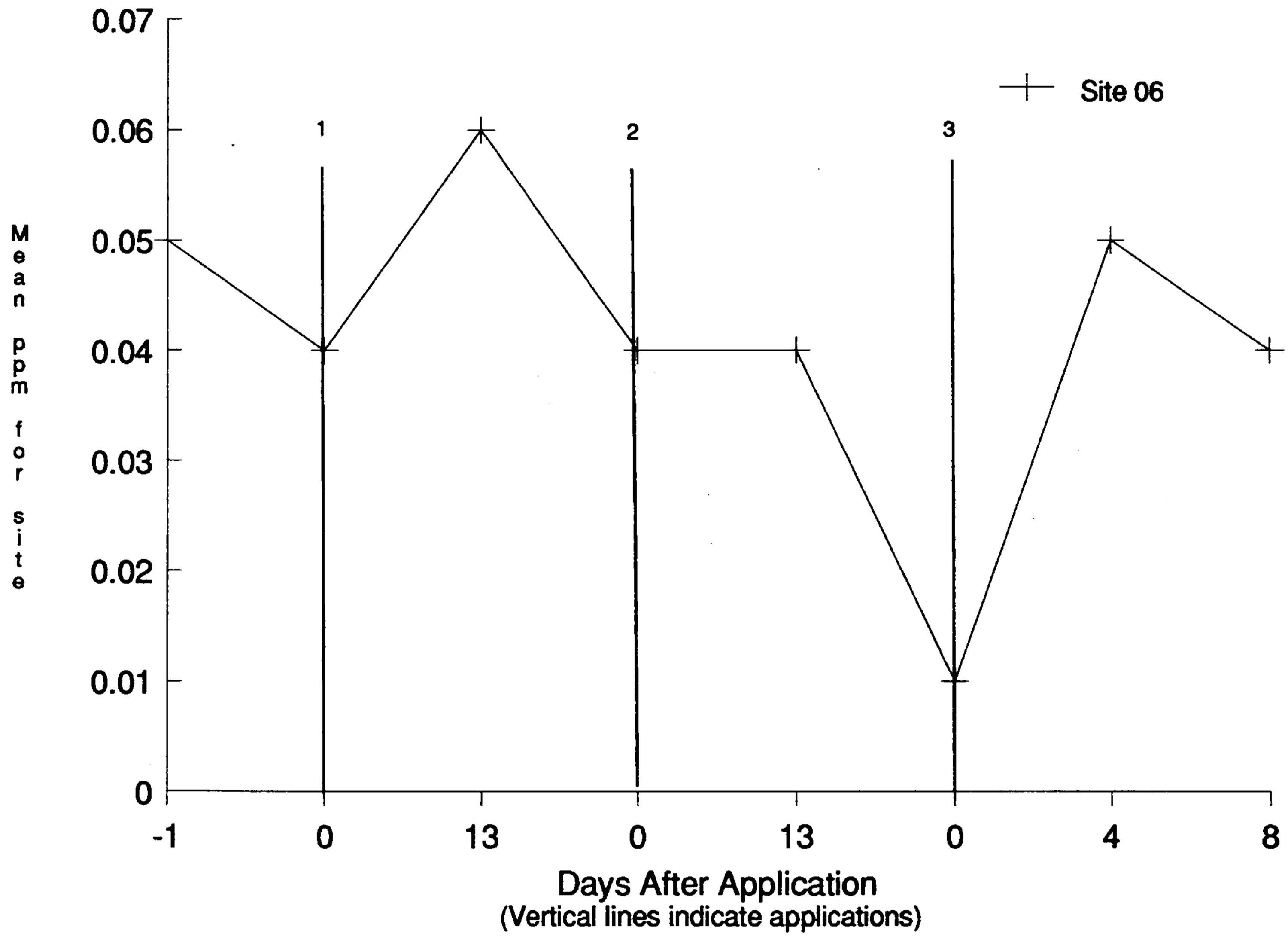


Figure II-7. Results of the first diazinon application air sampling, spring 1984. Application and watering periods are shown on the horizontal axis. Background concentrations are exaggerated for clarity.

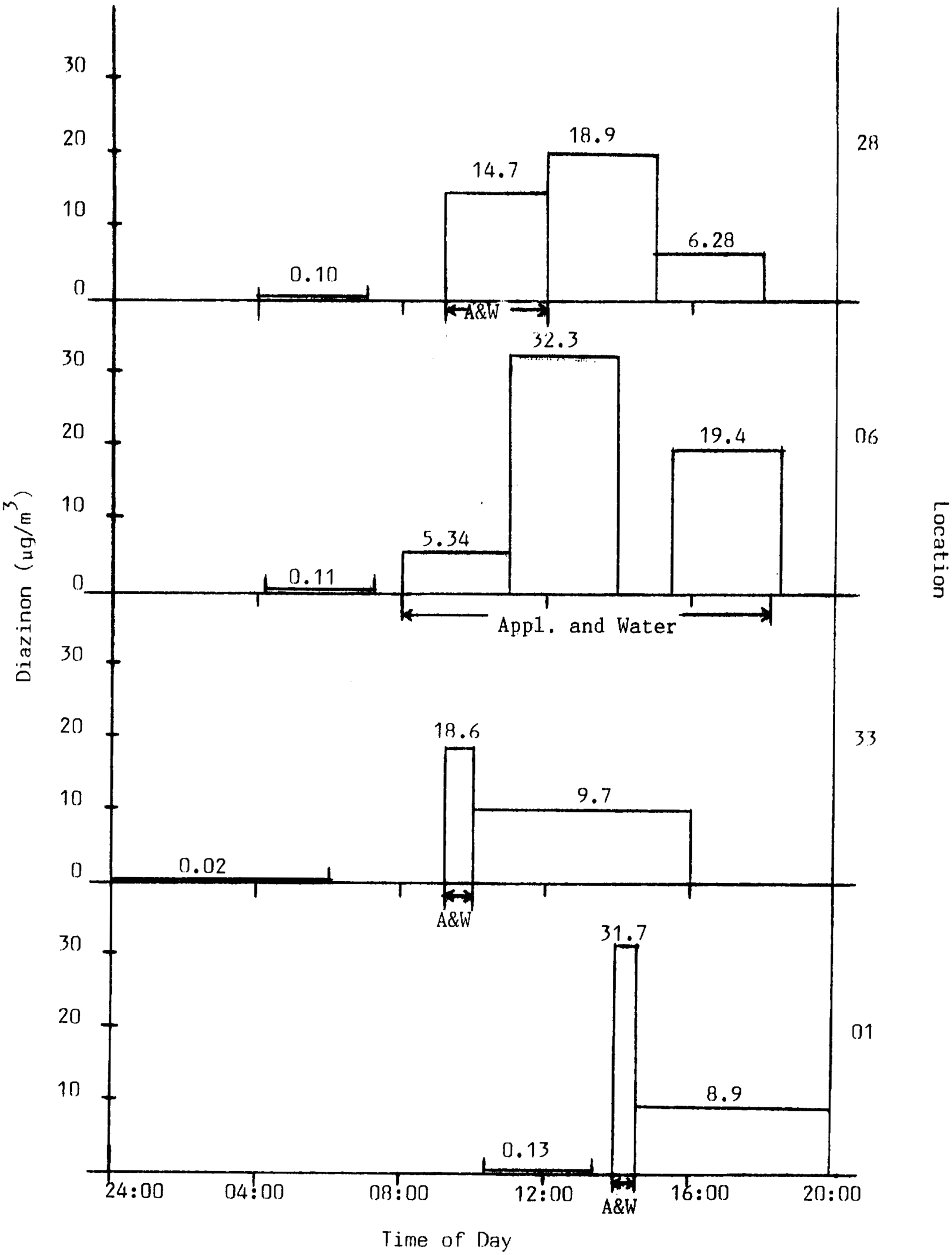


Figure II-8. Results of the second diazinon application air sampling, spring 1984. Application and watering periods are shown on the horizontal axis. Background concentrations are exaggerated for clarity.

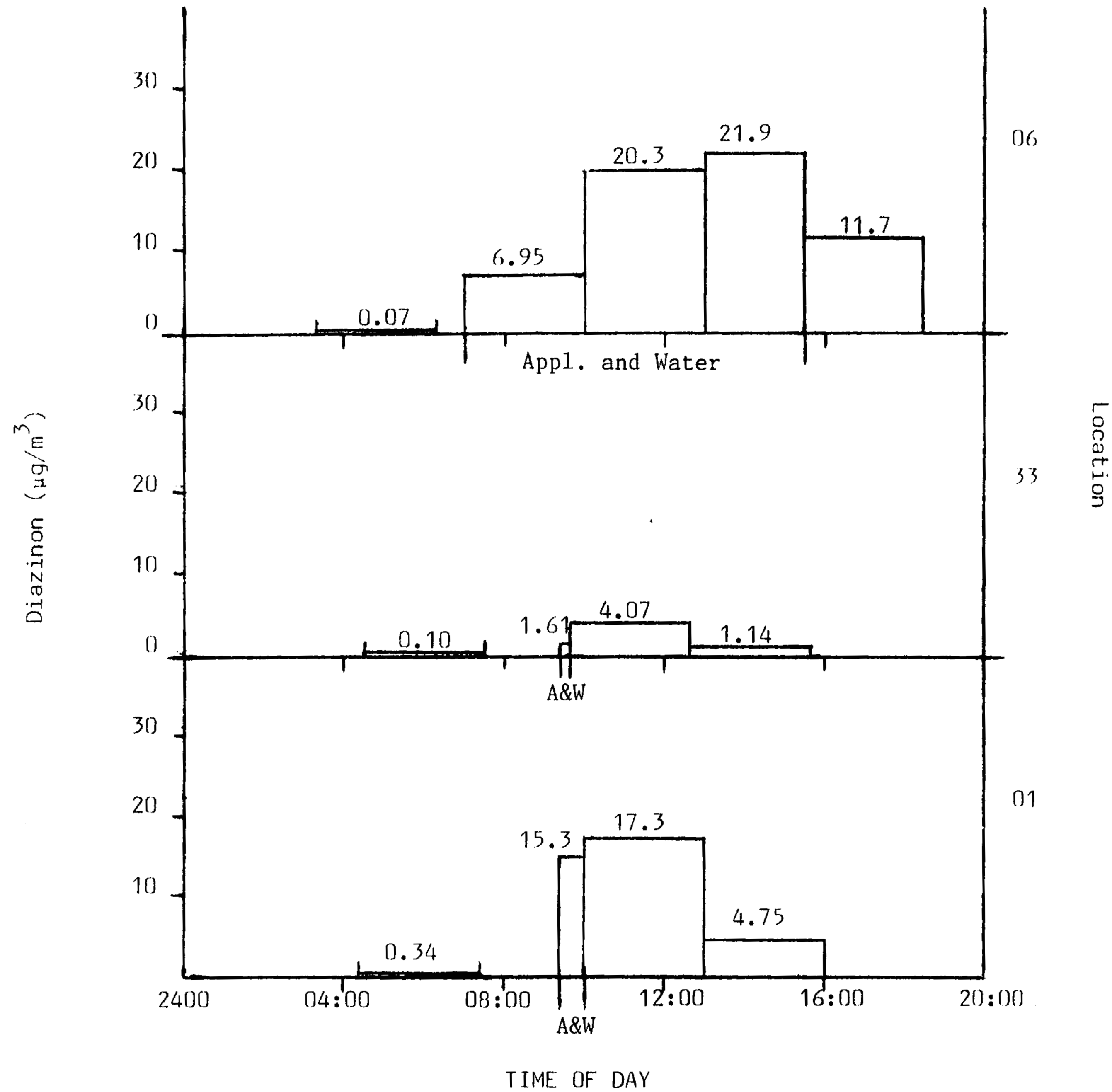


Table II-4. Results of the diazinon air flux monitoring, spring 1984, Japanese Beetle Project, Sacramento, 1983-6. These measurements were made immediately after a liquid diazinon application. Diazinon concentrations were measured at four heights, 25, 50, 100 and 200 cm. Wind speed and temperature were measured at two heights, 25 and 200 cm. The air flux values represent the amount of diazinon volatilizing through a horizontal plane at heighth of 113 cm.

	Diazinon, $\mu g/m^3$		Wind Speed, m/sec		Temperature, °C		Flux, $mg/m^2/hr$
Sampling Period	25 cm	200 cm	25 cm	200 cm	25 cm	200 cm	113 cm
3/24/84							
14:10 - 17:10	48.2	12.8	1.47	2.28	20.0	19.9	4.10
17:10 - 20:10	21.6	2.78	0.44	0.98	14.4	14.6	0.97
3/25/84							
04:50 - 07:50	7.33	4.63	0	0	8.0	8.2	0
07:50 - 10:50	33.9	8.47	1.18	1.65	17.0	16.8	2.48
10:55 - 13:50	38.2	10.0	1.43	1.83	22.8	22.6	6.74
13:50 - 16:50	21.6	5.79	1.65	2.37	22.0	23.1	1.33
16:50 - 19:50	19.1	3.70	1.65	2.64	17.5	17.8	1.69

Figure II-9. Diazinon air flux following the second application at location 6, spring 1984, Japanese Beetle Project, Sacramento, 1983-86. The time period shown is from 3/24/84, 2:10 p.m. to 3/25/84, 8:10 p.m.

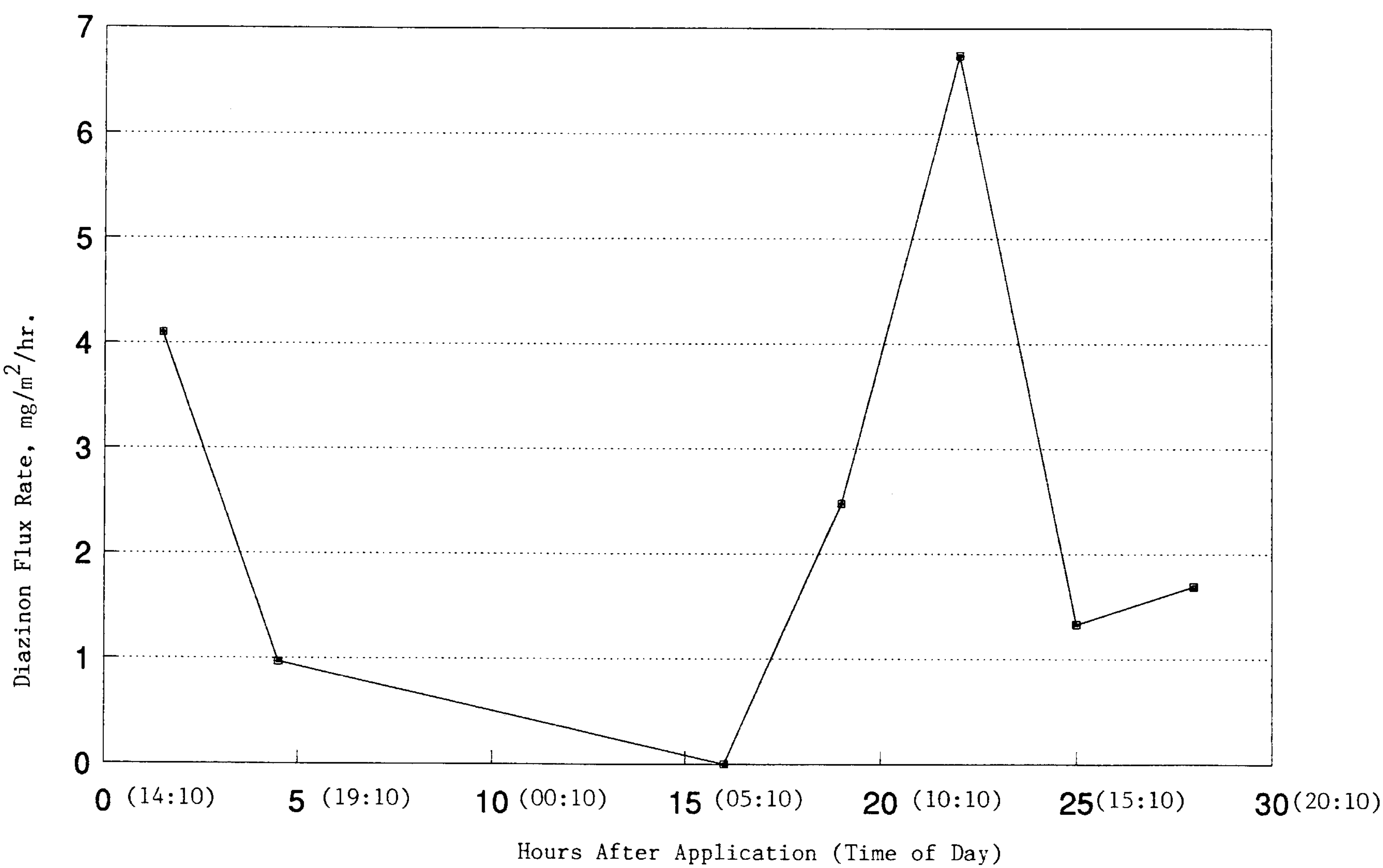


Table II-5. Results of the diazinon rain runoff monitoring, spring 1984, Japanese Beetle Project, Sacramento, 1983-6. Locations of sites are shown in Figure II-1.

		Concentration, ppb (Discharge, µg/sec)		
	Date:	2/15/84 (Bkgd)	3/13/84	4/10/84
Site	Rainfall:	1.27 cm	0.56 cm	0.56 cm
2		1.1 (2800)	<2.0 (0)[a]	1.7 (1500)
10		6.2 (120)	23 (23)	82 (330)
11		0.21 (0.84)	11 (110)	5.2 (310)
12		0.61 (61)	<2.0 (0)	<2.5 (0)
13		4.9 (98)	56 (110)	51 (2000)

a "<" indicates no detectable concentration and the detection limit

APPENDIX III

FALL 1984 DIAZINON TREATMENT

INTRODUCTION

Japanese beetles were found in old and new areas during the summer 1984 trapping season. Several of the beetles found were captured emerging from an ornamental strawberry patch. These detections created new areas and a new protocol for the fall 1984 diazinon treatment. The revised treatment areas are shown in Figure III-1. The new soil treatment protocol consisted of "fence to fence" diazinon applications. Areas treated under this protocol included ornamental plantings and fallow garden areas as well as turf and pastures. To avoid possible translocation in edible plants no gardens were allowed within the treatment areas.

Only the Dzn 14G® formulation was used for this and all subsequent soil treatments. This granular formulation was applied in the same manner as described in the main report. A total of 2730 kg of diazinon was applied between August 20 and October 3, 1984.

MATERIALS AND METHODS

Diazinon concentrations were monitored in turf/thatch, soil, air, fruit, and water. For turf/thatch and soil five locations were monitored, three residences, one school and one pasture. In addition, two residences were monitored for soil residues in fallow garden areas. All of these locations were sampled on 1, 5, 9, and 13 days after each application as well as 17 and 21 days following the third and final application. This schedule differs from previous treatments and was changed because of problems with sampling on the day of application (Day 0). Application and watering occurred until late afternoon and the turf could not dry before the next day. Since sampling wet turf would invalidate the dislodgable analysis the sampling was initiated the day after application. Turf and thatch were combined into one sample and analyzed for both dislodgable and internal residue. Soil samples were collected from three depths, 0-2.5, 0-15 and 15-30 cm.

The three turf/thatch residences were also sampled for air concentrations before during and after the first two applications. Additional air samples were collected for the second application at the two schools treated.

Fruit samples were collected from apple, fig, grape, grapefruit, lemon, lime, orange, pecan, persimmon, pomegranate, and walnut trees. Both preharvest and harvest samples were collected.

Both surface and ground water were monitored. Surface water samples consisted of background samples, irrigation runoff samples during the six week treatment period, and rain runoff samples during the first three rain storms. The California Department of Fish and Game also monitored two sites during this treatment, Arcade Creek at Norwood Avenue (approximately 25 km downstream of the treatment areas, near the Sacramento River) and the American River at Sunrise Blvd. Ground water was sampled from the one well within the treatment area.

RESULTS AND DISCUSSION

Turf/Thatch

Turf/thatch dislodgable concentrations ranged between 0.26 and 55 mg/m^2 (Table III-1, Figure III-2), while total concentrations ranged between 2.1 and 640 mg/m^2 (Table III-2, Figure III-3). The dislodgable residue represents 0.04 to 8.6% of the 641 mg/m^2 of diazinon applied, while the total residue represents 0.3 to 100%. The dissipation rate for this treatment, as with all other treatments, was rapid. The average total residue for day 1 ranged from 97 to 230 mg/m^2 and the day 13 averages ranged from 4.7 to 16 mg/m^2.

The statistical analysis showed that total turf/thatch residue on days 1 and 5 were significantly higher than days 9 and 13 for each application and day 21 of the last application was significantly lower than day 9. The ANOVA also showed that application 1 had the highest overall level, with application 3 having less, and application 2 having the least. Thus, no accumulation of diazinon from application to application was evident. Details of the statistical analysis appears in Appendix VII.

Soil

Surface soil samples (0-2.5 cm) contained much more diazinon than the soil core samples. Concentrations at this depth ranged from nondetectable to 560 mg/m^2, or 18 ppm, representing up to 87% of the applied diazinon (Tables III-3 and III-4, Figures III-4 and III-5). In contrast, concentrations at the 0-15 cm depth ranged from nondetectable to 2.5 ppm and nondetectable to 2.8 ppm for the 15-30 cm depth (Tables III-5 and III-6, Figures III-6 and III-7). Concentrations at all depths declined rapidly. At Day 13 concentrations were less than one-tenth of initial levels at the 0-2.5 cm depth and nondetectable at the 0-15 and 15-30 cm depths.

Soil samples from fallow garden areas had much higher concentrations than the soil samples collected from the turf areas. This was expected since the diazinon was applied to bare soil in the fallow garden areas. Concentrations ranged from 25 to 590 mg/m^2 or 0.73 to 14 ppm (Table III-7 and Figure III-8). As with the other media, dissipation was rapid.

As with turf/thatch the ANOVA showed that a significant decrease in diazinon occurred between days 1, 5, and 9 for the 0-2.5 cm depth. No significant difference was found between days 9 and 17 of the last application; all day 21 samples were none detected. This indicates that most of the dissipation occurred between days 1 and 9. For the 0-2.5 cm depth application 1 had the highest overall concentration and was significantly higher than applications 2 and 3 which were not significantly different from each other. Statistical analysis of the other depth was not possible primarily because there were so many negative samples. Details of the analysis of variance is found in Apendix VII.

Air

Air concentrations for this treatment were lower than the spring 1984 treatment, ranging from 0.03 to 9.9 $\mu g/m^3$ (Figures III-9, III-10). Concentrations were probably lower because of the formulation change from an emulsifiable concentrate to granules. Emulsifiable concentrates generally have greater volatility and greater potential for drift than granules. Additional post application samples were collected the day after treatment for the first time. These concentrations, ranging from 0.14 to 6.7 $\mu g/m^3$, were comparable to those detected immediately after application and watering (0.58 to 7.1 $\mu g/m^3$). In addition, all background samples were positive. These results taken together indicate that diazinon was probably present throughout the six-week treatment period.

Fruit

Of the 68 preharvest and harvest samples 2 were positive at 0.1 ppm, fresh weight basis (Table III-8). One fig samples was confirmed positive by a second sample from the same tree, one persimmon sample was unconfirmed since the second sample had no residue (detection limit 0.1 ppm). The fig sample was below the 0.5 ppm tolerance; no tolerance exists for diazinon in persimmons. These samples were the only positives during the entire Japanese Beetle Project. Additional fig and persimmon samples collected from other properties contained no diazinon, and other commodities from the positive sites also had no diazinon. The positive sites were not resampled during later treatments because the persimmon site was not treated and the fig site did not bear any fruit.

Water

Background surface water samples showed detectable residue at 5 of the 7 sites (Table III-9). This data indicates that most if not all of the background diazinon is from other applications and not earlier Japanese beetle treatments. The sites which received drainage from previously treated areas (sites 2, 6, 12, 14) had little or no diazinon detected, while the sites which received drainage from areas never treated by the Japanese Beetle Project (sites 15, 16, 17) had significant amounts of diazinon.

Irrigation runoff samples were collected twice a week during the six-week treatment period. The concentrations detected varied with time and location, ranging from none detected to 73 ppb (Table III-9). The highest discharge rates occurred at site 17, since this site drained the most area (Table III-9 and Figure III-11). The monitoring showed a fairly constant amount of diazinon discharged during the first four weeks of the treatment. The variations during the last two weeks were mainly due to variations in concentrations. The mass discharge from all Japanese beetle treatment areas combined was estimated by adding the discharges of sites 2, 14, and 17. The average discharge was 63 grams of diazinon per day and the total amount discharged, 3.1 kg, was 0.11% of the total 2730 kg applied.

Rain runoff samples were collected during the first three rain storms of the season. The concentrations ranged from 0.4 to 35 ppb, while discharge rates varied from 1.0 to 5100 µg/sec (Table III-10). Total discharge for all sites combined was greater than 5100 µg/sec or 18 g/hr on August 30th and

3230 µg/sec or 12 g/hr on October 16th, 1984. Water flows could not be measured or discharges calculated for 11-7-84.

None of the samples collected by CDFG from the American River or Arcade Creek near the Sacramento River on August 16th, August 31st, September 13th, or September 28th showed detectable residue (detection limit 1.0 ppb).

Ground water samples collected on August 31st and October 2nd, 1984 from one well contained no diazinon (detection limit 0.1 ppb).

Figure III-1. Diazinon treatment areas, fall 1984. Numbered locations indicate water sampling sites.

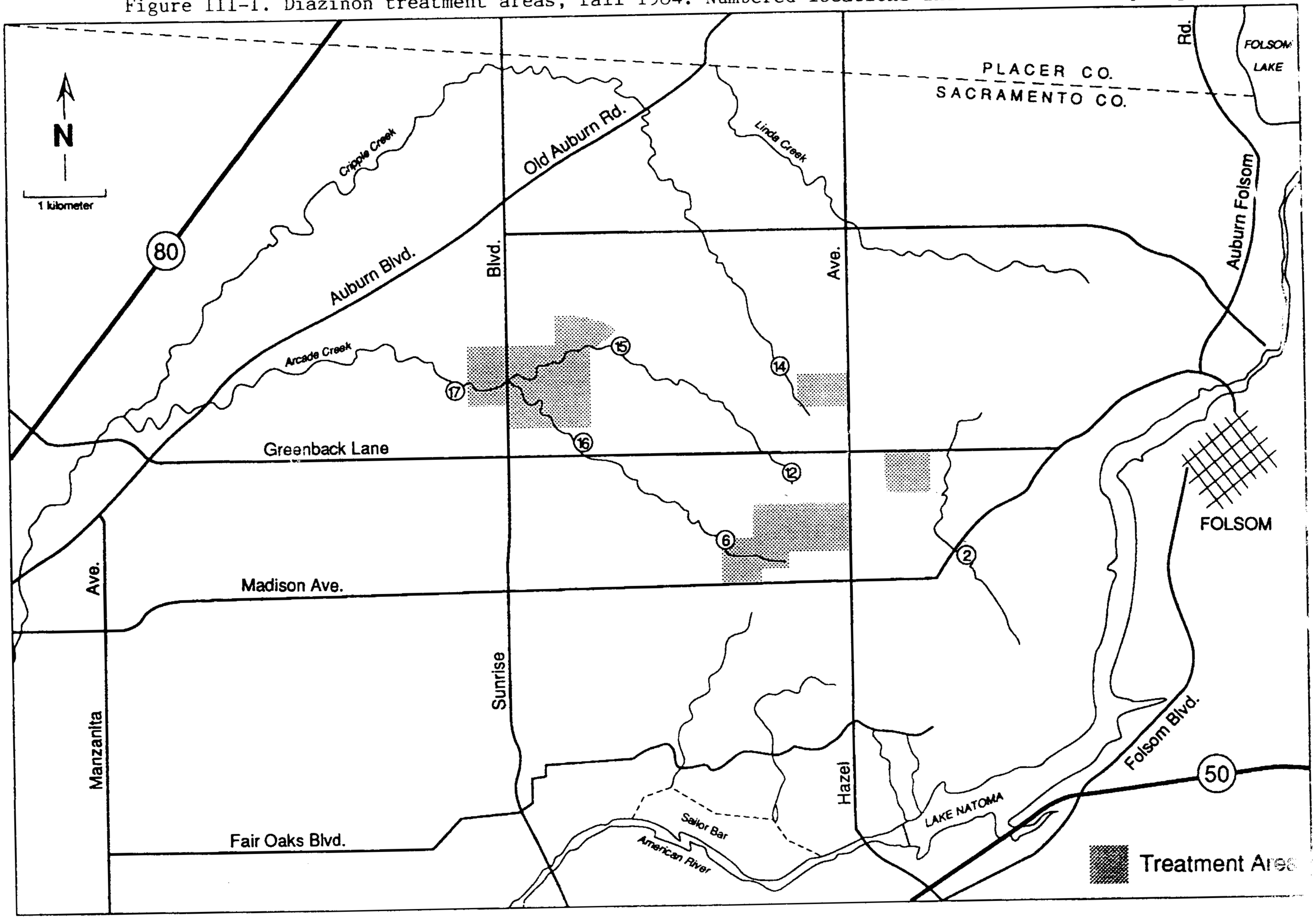


Table III-1. Summary statistics for dislodgable diazinon concentrations in turf/thatch, fall 1984, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the five site (Locations 06, 35, 40, 41, 48) means. Values below the detection limit are calculated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

		Diazinon Concentration, mg/m^2			
Sampling Day	# of Sites	Mean	Standard Error	Max	Min
Application 1					
Background	1	ND[a]	---	ND	ND
1	1	27	---	27	27
5	0	---	---	---	---
9	5	7.5	3.3	20	0.66
13	4	2.2	0.40	3.3	1.5
Application 2					
1	4	15	7.5	35	ND
5	5	4.3	1.3	9.3	2.2
9	5	2.2	0.81	4.7	ND
13	4	0.99	0.29	1.5	ND
Application 3					
1	5	29	7.7	55	7.7
5	5	11	2.4	17	5.5
9	5	2.8	0.73	4.2	ND
13	5	0.57	0.13	0.97	ND
17	5	0.68	0.03	0.75	ND
21	5	ND	---	ND	ND

a ND - None Detected, with a detection limit of approximately 0.4 mg/m^2.

Table III-2. Summary statistics for total (dislodgable + internal) diazinon concentrations in turf/thatch, fall 1984, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the five site (Locations 06, 35, 40, 41, 48) means. Values below the detection limit are calculated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

		Diazinon Concentration, mg/m^2			
Sampling Day	# of Sites	Mean	Standard Error	Max	Min
Application 1					
Background	5	ND[a]	---	ND	ND
1	5	190	48	370	110
5	4	120	23	160	76
9	5	32	13	64	5.1
13	4	16	3.4	26	10
Application 2					
1	4	97	28	160	21
5	5	38	11	71	15
9	5	41	27	150	ND
13	4	12	5.0	23	ND
Application 3					
1	5	230	81	550	77
5	5	200	110	640	27
9	5	20	4.4	30	8.4
13	5	4.7	1.3	9.7	ND
17	5	5.0	0.38	6.0	ND
21	5	5.6	1.4	11	ND

a ND - None Detected, with a detection limit of approximately 2 mg/m^2.

Figure III-2. Dislodgable Diazinon in Turf/Thatch Samples
Fall 1984.

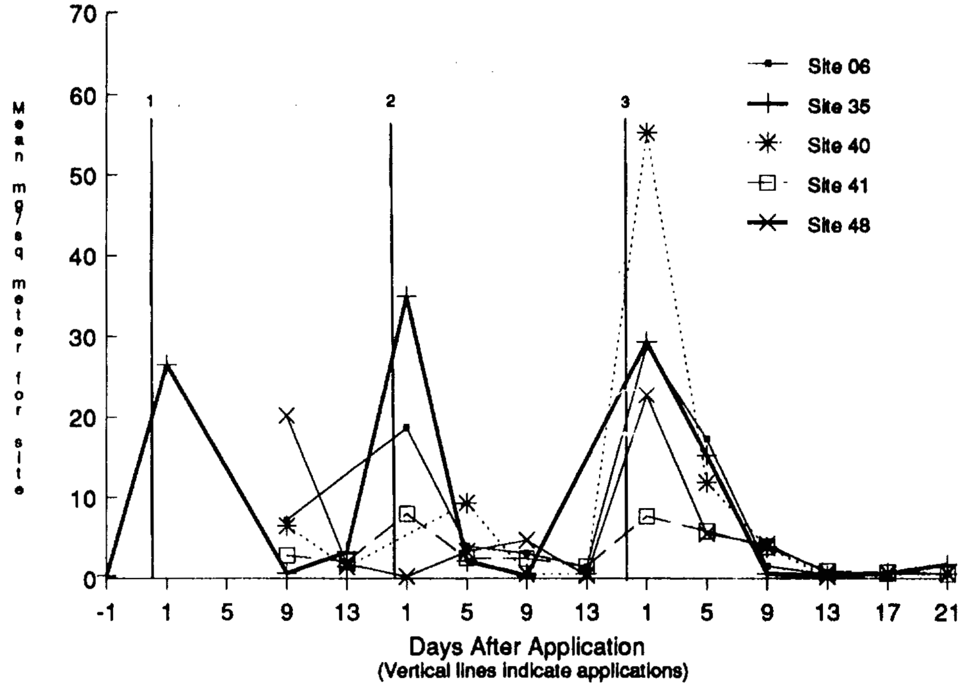


Figure III-3. Total Diazinon in Turf/Thatch Samples
Fall 1984.

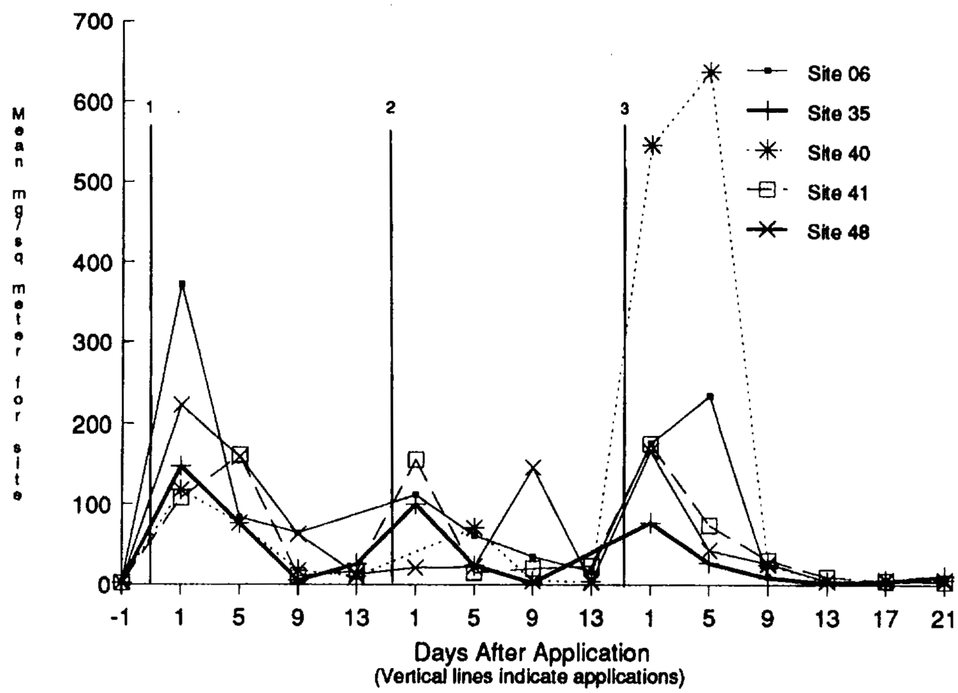


Table III-3. Summary statistics for diazinon concentrations in soil (0-2.5 cm, mg/m^2), Fall 1984, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the five site (Locations 06, 35, 40, 41, 48) means. Values below the detection limit are calculated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

Sampling Day	# of Sites	Diazinon Concentration, mg/m^2 Mean	Standard Error	Max	Min
Application 1					
Background	5	ND (1.7)[a]	ND (0.11)	ND (2.1)	ND (1.5)
1	5	290	110	560	92
5	4	190	53	310	53
9	5	58	37	200	6.2
13	4	21	5.4	33	6.4
Application 2					
1	4	77	33	170	24
5	5	43	14	95	16
9	5	15	12	64	ND (1.7)
13	4	3.1	1.1	5.5	ND (1.1)
Application 3					
1	5	160	66	370	20
5	5	60	31	140	6.6
9	5	5.1	1.0	7.8	2.7
13	5	3.0	0.68	5.1	ND (1.4)
17	5	2.9	0.61	5.1	ND (1.9)
21	5	ND (1.8)	ND (0.22)	ND (2.4)	ND (1.3)

a ND - None Detected, with the value indicating 1/2 the detection limit

Table III-4. Summary statistics for diazinon concentrations in soil (0-2.5 cm, ppm), fall 1984, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the five site (Locations 06, 35, 40, 41, 48) means. Values below the detection limit are calculated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

Sampling Day	# of Sites	Diazinon Concentration, ppm Mean	Standard Error	Max	Min
Application 1					
Background	5	ND (0.05)[a]	---	ND (0.05)	ND (0.05)
1	5	7.9	3.3	18	2.3
5	4	5.4	1.6	8.8	1.4
9	5	1.7	1.1	6.0	0.15
13	4	0.57	0.16	0.93	0.15
Application 2					
1	4	2.4	0.94	5.0	0.85
5	5	1.9	0.72	4.6	0.58
9	5	0.53	0.44	2.3	ND (0.05)
13	4	0.11	0.04	0.21	ND (0.05)
Application 3					
1	5	5.0	2.2	12	0.58
5	5	2.0	1.1	5.1	0.15
9	5	0.16	0.02	0.24	0.08
13	5	0.13	0.03	0.24	ND (0.05)
17	5	0.08	0.02	0.18	ND (0.05)
21	5	ND (0.05)	---	ND (0.05)	ND (0.05)

a ND - None Detected, with the value indicating 1/2 the detection limit

Figure III-4. Diazinon in Soil Samples (0-2.5 cm, mg/sq m)
Fall 1984.

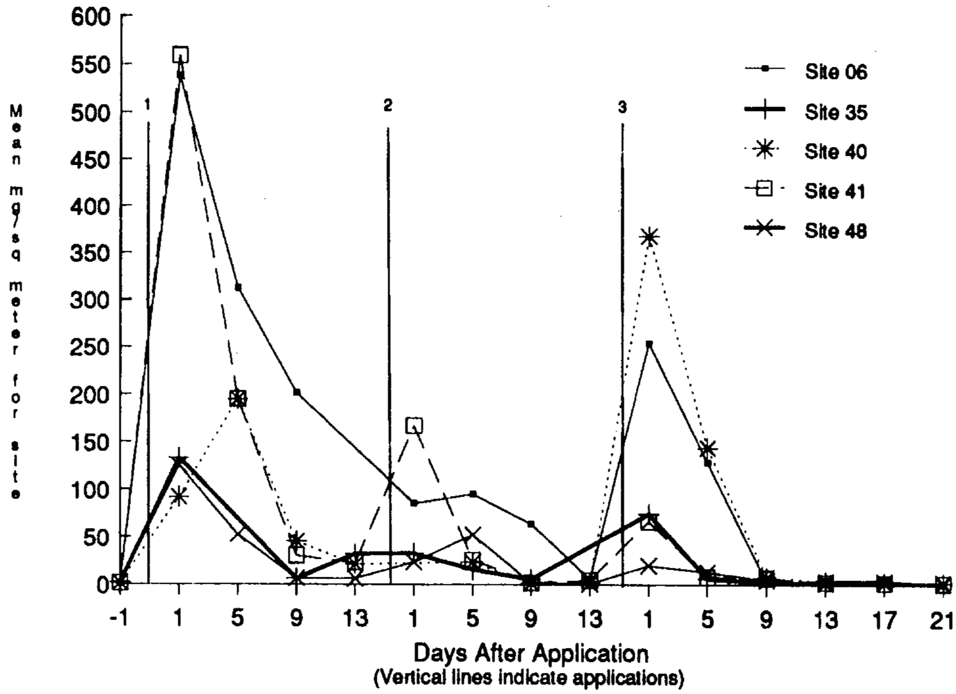


Figure III-5. Diazinon in Soil Samples (0-2.5 cm, ppm)
Fall 1984.

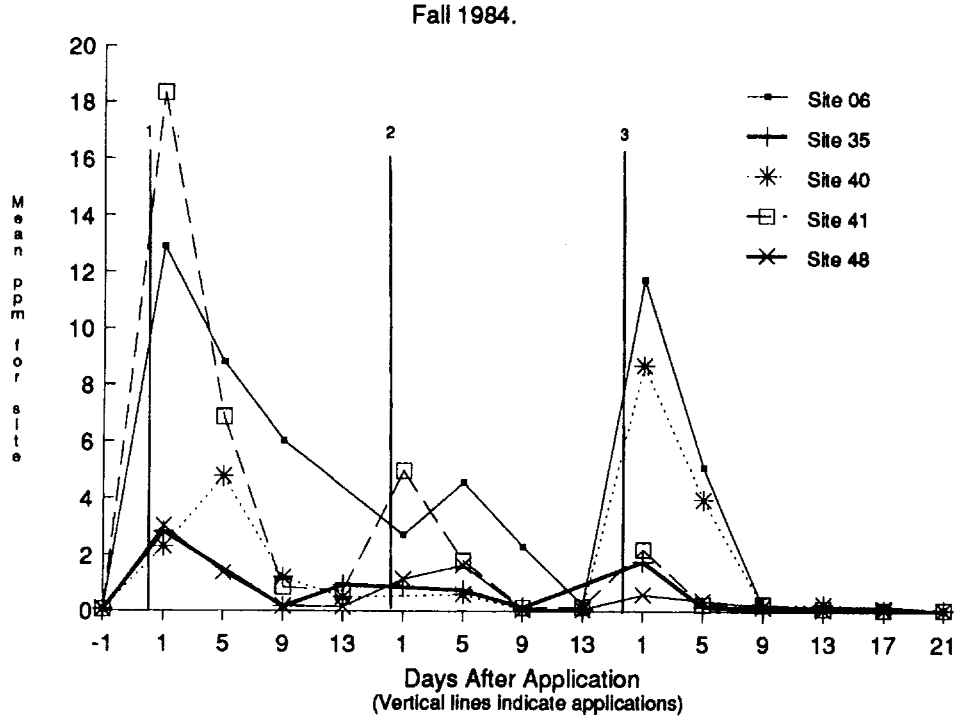


Table III-5. Summary statistics for diazinon concentrations in soil (0-15 cm, ppm), fall 1984, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the five site (Locations 06, 35, 40, 41, 48) means. Values below the detection limit are calculated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

		Diazinon Concentration, ppm			
Sampling Day	# of Sites	Mean	Standard Error	Max	Min
Application 1					
Background	5	ND (0.05)[a]	---	ND (0.05)	ND (0.05)
1	5	0.70	0.45	2.5	ND (0.05)
5	4	0.37	0.09	0.58	0.16
9	5	0.14	0.05	0.30	ND (0.05)
13	4	0.08	0.03	0.16	ND (0.05)
Application 2					
1	4	0.73	0.41	1.9	0.11
5	5	0.12	0.05	0.27	ND (0.05)
9	5	0.06	0.01	0.09	ND (0.05)
13	4	ND (0.05)	---	ND (0.05)	ND (0.05)
Application 3					
1	5	0.58	0.43	2.3	ND (0.05)
5	5	0.23	0.11	0.50	ND (0.05)
9	5	ND (0.05)	---	ND (0.05)	ND (0.05)
13	5	ND (0.05)	---	ND (0.05)	ND (0.05)
17	5	ND (0.05)	---	ND (0.05)	ND (0.05)
21	5	ND (0.05)	---	ND (0.05)	ND (0.05)

a ND - None Detected, with the value indicating 1/2 the detection limit

Table III-6. Summary statistics for diazinon concentrations in soil (15-30 cm, ppm), fall 1984, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the five site (Locations 06, 35, 40, 41, 48) means. Values below the detection limit are calculated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

		Diazinon Concentration, ppm			
Sampling Day	# of Sites	Mean	Standard Error	Max	Min
Application 1					
Background	5	ND (0.05)[a]	---	ND (0.05)	ND (0.05)
1	5	0.18	0.06	0.34	ND (0.05)
5	4	0.11	0.05	0.25	ND (0.05)
9	5	0.25	0.20	1.1	ND (0.05)
13	4	ND (0.05)	---	ND (0.05)	ND (0.05)
Application 2					
1	4	0.12	0.03	0.18	ND (0.05)
5	5	0.07	0.02	0.15	ND (0.05)
9	5	ND (0.05)	---	ND (0.05)	ND (0.05)
13	4	ND (0.05)	---	ND (0.05)	ND (0.05)
Application 3					
1	5	0.10	0.03	0.23	ND (0.05)
5	5	0.62	0.55	2.8	ND (0.05)
9	5	0.06	0.01	0.09	ND (0.05)
13	5	ND (0.05)	---	ND (0.05)	ND (0.05)
17	5	ND (0.05)	---	ND (0.05)	ND (0.05)
21	5	ND (0.05)	---	ND (0.05)	ND (0.05)

a ND - None Detected, with the value indicating 1/2 the detection limit

Figure III-6. Diazinon in Soil Samples (0-15 cm)
Fall 1984.

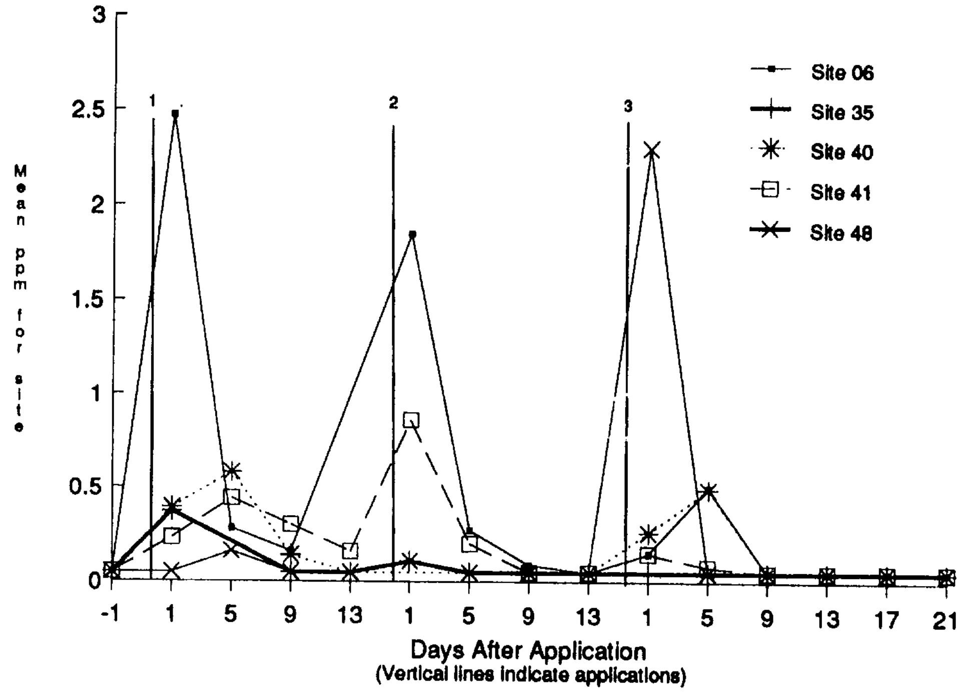


Figure III-7. Diazinon in Soil Samples (15-30 cm)
Fall 1984.

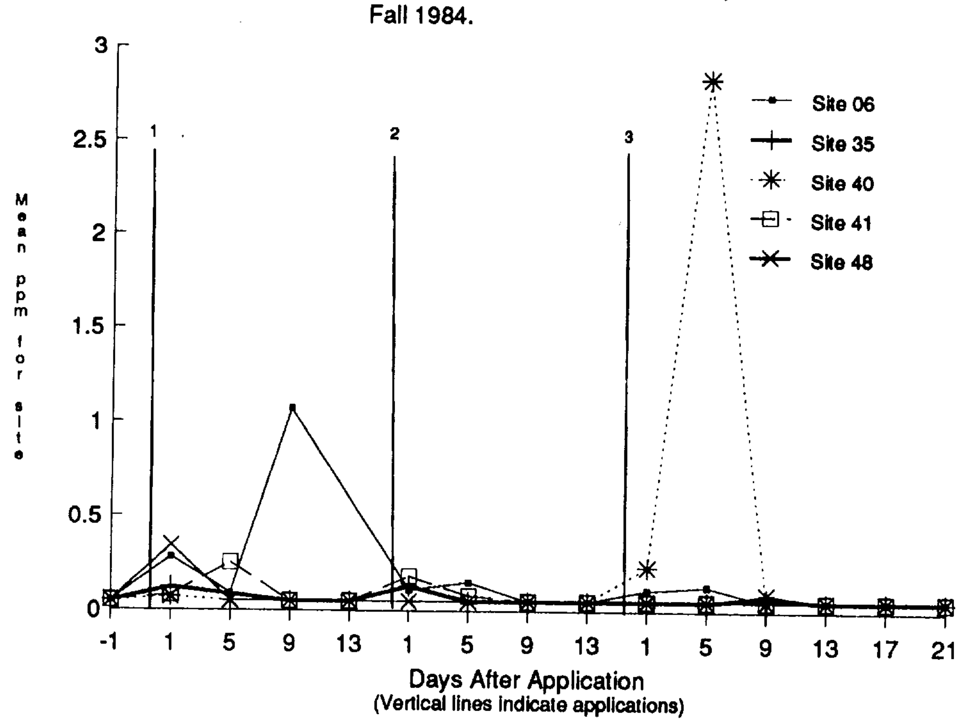
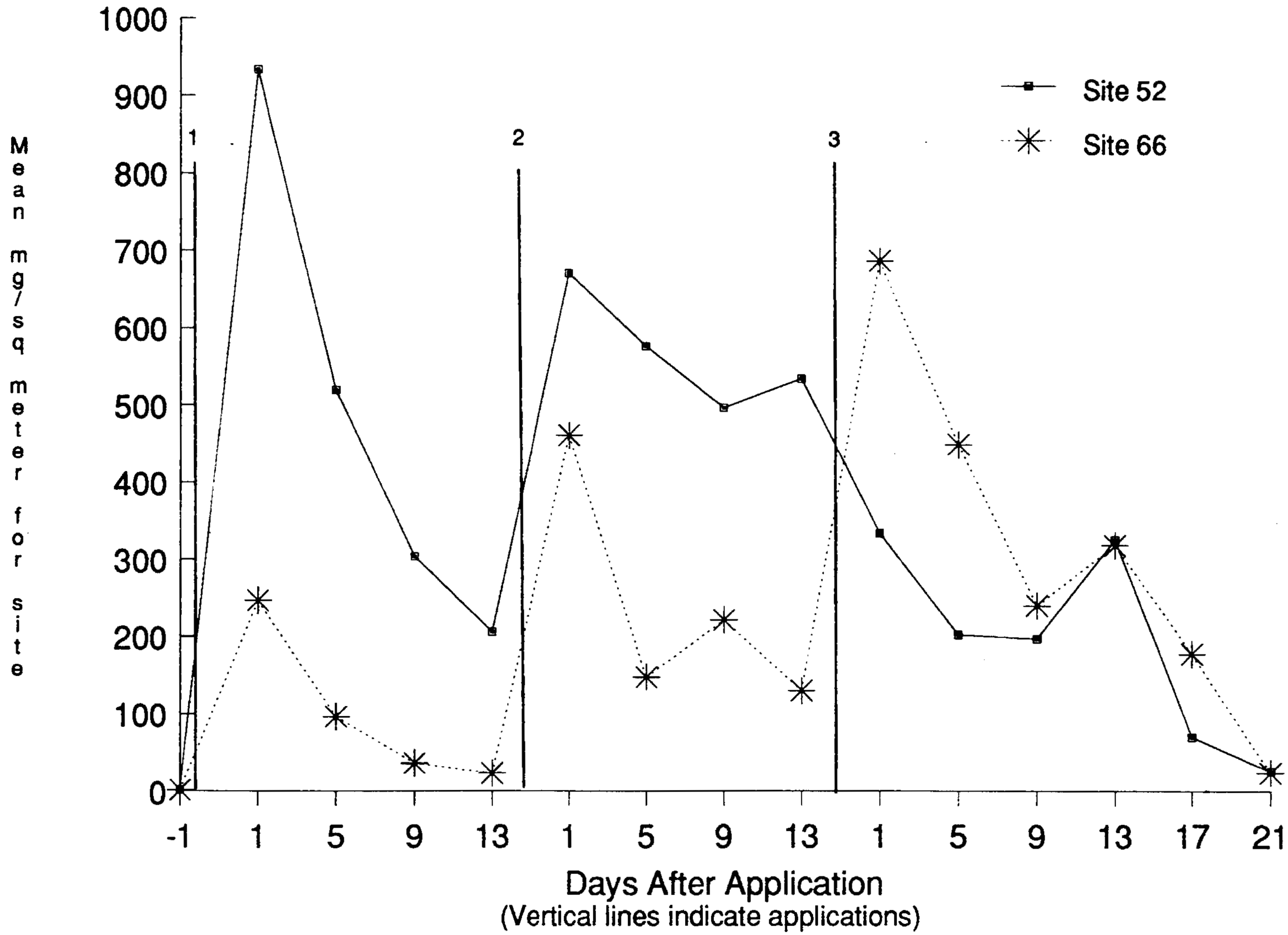


Table III-7. Summary statistics for diazinon concentrations in garden soil (0-2.5 cm), fall 1984, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the two site (Locations 52, 66) means. Values below the detection limit are calculated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

		Diazinon, mg/m^2		Diazinon, ppm	
Sampling Day	# of Sites	Mean	Standard Error	Mean	Standard Error
Application 1					
Background	2	ND (0.05)[a]	---	ND (0.05)	---
1	2	590	340	14	6.6
5	2	310	210	9.4	6.9
9	2	170	130	4.5	3.6
13	2	110	91	4.1	3.6
Application 2					
1	2	570	110	13	4.0
5	2	360	210	8.2	4.7
9	2	360	140	6.5	2.0
13	2	330	200	6.7	3.0
Application 3					
1	2	510	180	11	4.6
5	2	330	120	6.1	2.5
9	2	220	22	4.4	0.91
13	2	320	5.0	6.7	0.14
17	2	120	54	2.2	0.71
21	2	25	0.97	0.73	0.21

a ND - None Detected, with the value indicating 1/2 the detection limit

Figure III-8. Diazinon in Soil Samples (0-2.5 cm)
From Two Garden Sites, Fall 1984.



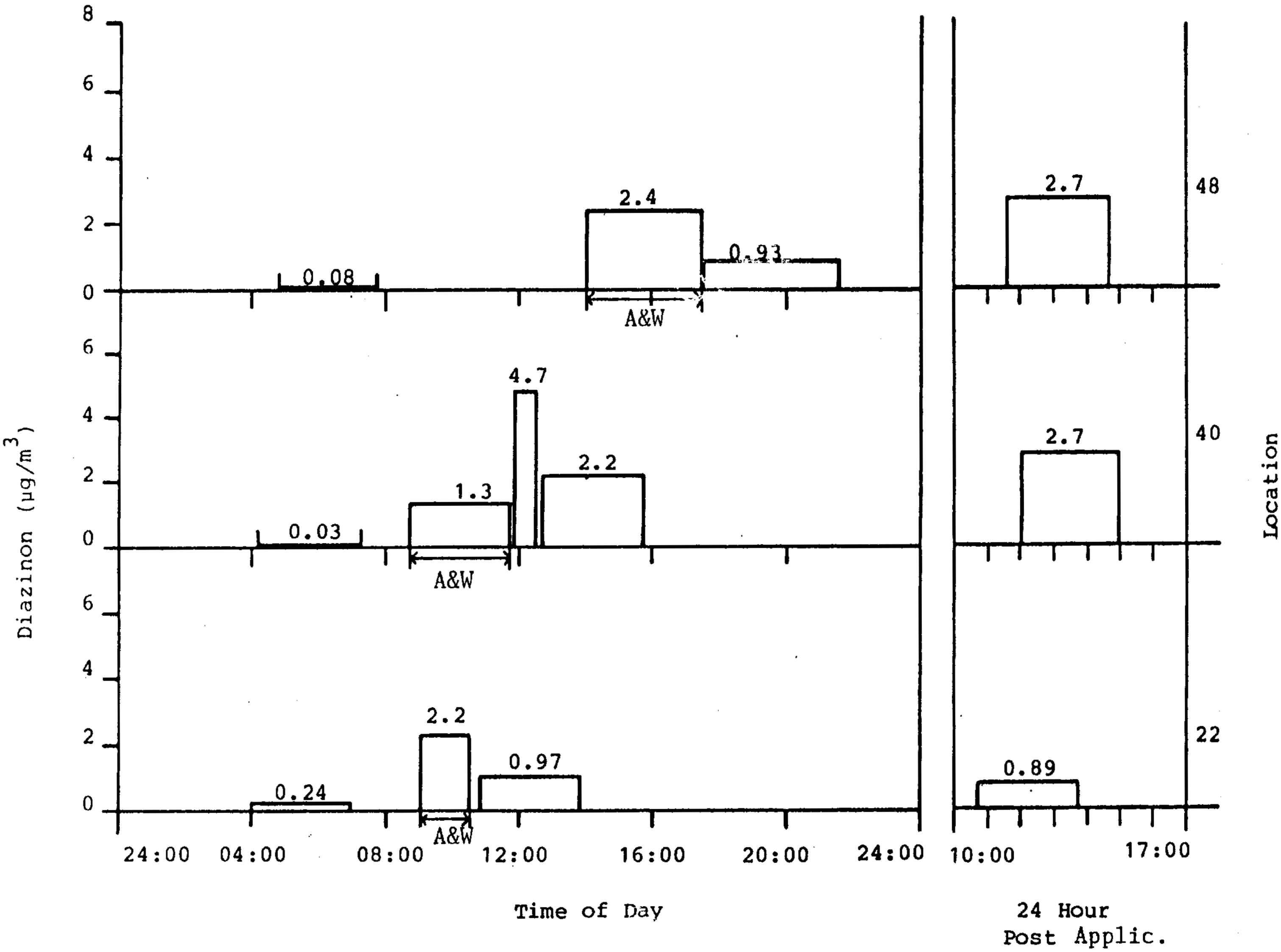


Figure III-9. Results of the first diazinon application air sampling, fall 1984. Application and watering periods (A&W) are shown on the horizontal axis.

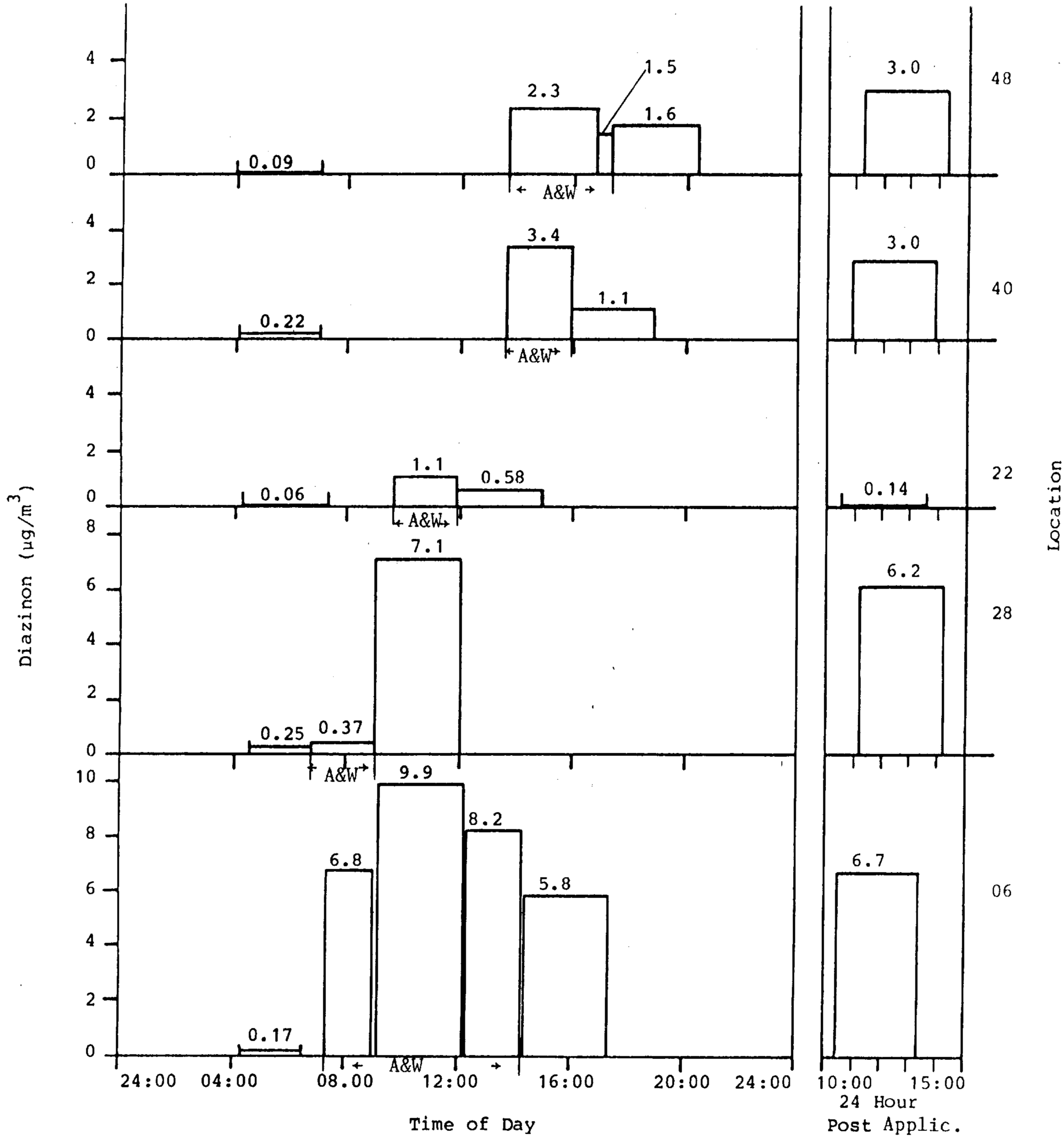


Figure III-10. Results of the second diazinon application air sampling, fall 1984. Application and watering periods (A&W) are shown on the horizontal axis.

Table III-8. Results of the diazinon fruit sampling, fall 1984, Japanese Beetle Project, Sacramento, 1983-6.

	Number of Properties Sampled	Sampling Period, Days After 1st Application	
		Preharvest	Harvest
Apples	4	12 - 17	26 - 28
Figs[a]	4(3)[b]	13 - 19	28 - 33
Grapes	8	7 - 21	21 - 35
Grapefruit	3	32 - 110	126 - 134
Lemon	1	47	not sampled
Lime	1	25	48
Oranges	5	66 - 72	108 - 126
Pecans	2	32 - 33	77 - 78
Persimmons[a]	3	32 - 50	55 - 89
Pomegranate	1	not sampled	55
Walnuts	4(3)[b]	7 - 21	21 - 35

a One fig and one persimmon sample were positive at 0.1 ppm

b The number in parentheses indicates the number of harvest properties

Table III-9. Results of the diazinon irrigation runoff monitoring, fall 1984, Japanese Beetle Project, Sacramento, 1983-6. Locations of monitoring sites are shown in Figure III-1.

	Diazinon Concentration, ppb (Diazinon Discharge, µg/sec)					
Date / Site:	2	6	12	14	15	17
8/17/84 (Background)	0.8 (19)	1.6 (15)	ND (0)[a]	ND (0)	1.5 (23)	2.9 (350)
8/20/84	0.3 (9.6)	1.3 (11)	ND (0)	0.3 (0)	0.8 (1.6)	7.1 (600)
8/23/84	7.5 (71)	20 (220)	0.4 (0.8)	ND (0)	0.6 (7.2)	11 (1300)
8/27/84	2.8 (27)	38 (320)	ND (0)	ND (0)	3.2 (21)	3.1 (470)
8/30/84[b]	0.6 (9.8)	73 (530)	ND (0)	ND (0)	1.0 (8.9)	8.9 (680)
9/3/84	6.3 (64)	16 (82)	ND (0)	1.0 (1.7)	0.8 (6.8)	6.7 (710)
9/6/84	1.6 (15)	6.8 (41)	ND (0)	ND (0)	0.7 (4.0)	6.4 (730)
9/10/84	0.5 (5.8)	14 (76)	ND (0)	ND (0)	0.5 (5.3)	4.0 (680)
9/13/84	1.3 (15)	0.8 (4.3)	ND (0)	ND (0)	0.5 (26)	5.5 (930)
9/17/84	ND (0)	1.3 (8.8)	0.2 (0.5)	0.2 (0)	ND (0)	ND (0)
9/20/84	26 (369)	9.8 (277)	ND (0)	ND (0)	ND (0)	13 (1800)
9/24/84	0.3 (4.3)	1.9 (36)	ND (0)	ND (0)	ND (0)	3.5 (500)
9/27/84	0.4 (6.8)	6.2 (28)	ND (0)	12 (0)	0.8 (17)	15 (1700)
10/1/84	0.5 (10)	3.6 (16)	ND (0)	0.3 (0)	1.2 (17)	1.2 (200)
10/4/84	4.8 (82)	0.5 (2.3)	ND (0)	0.3 (0)	10 (106)	0.7 (59)

a ND - None Detected, detection limit 0.1 ppb

b Irrigation runoff samples collected at 1000 hrs, rain runoff collected at 1600 hrs on 8/30/84. See Table III-10 for rain runoff results.

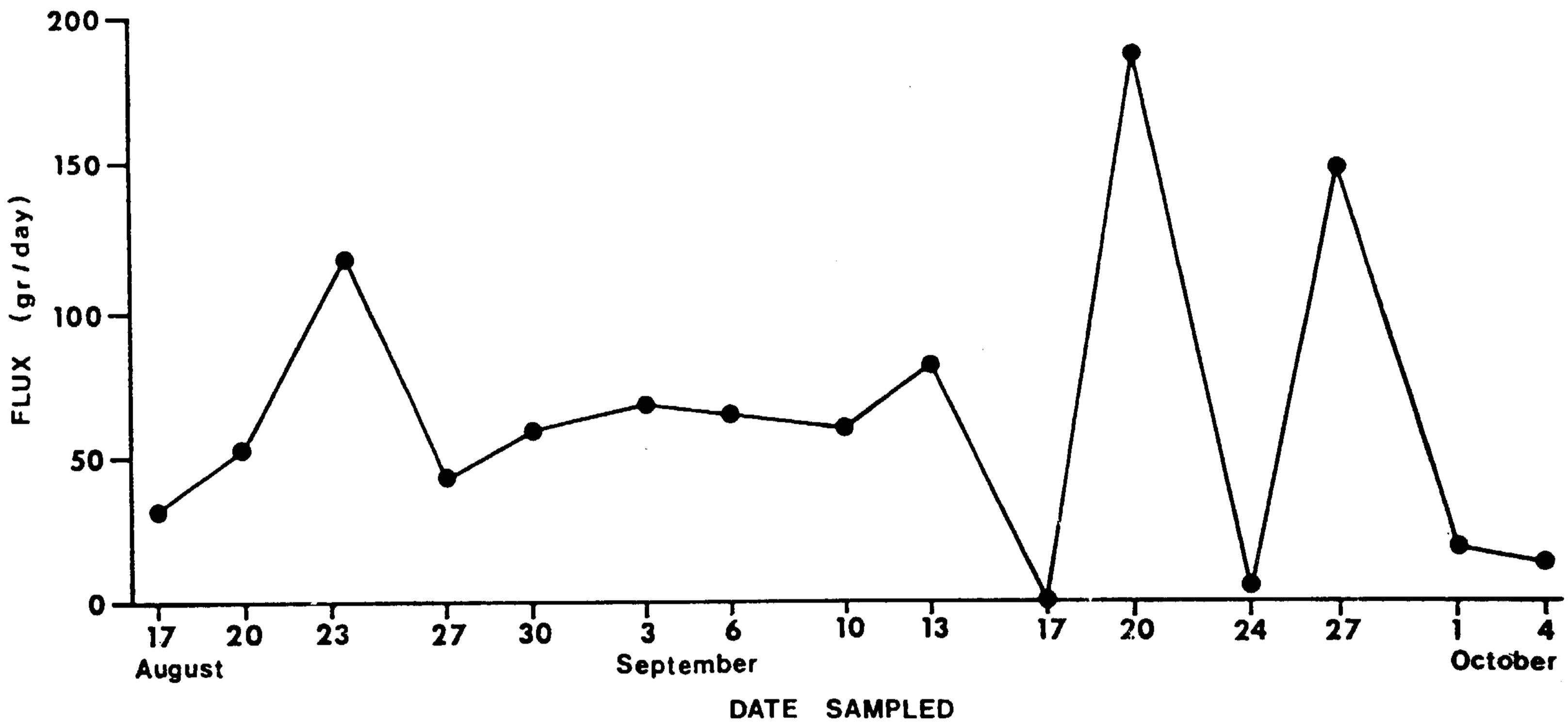


Figure III-11. Diazinon irrigation runoff from the Japanese Beetle treatment area, Fall 1984. The graph shows the total amount of diazinon leaving the treatment area via waterways. Diazinon was applied between August 20 and October 3, 1984.

Table III-10. Results of the diazinon rain runoff monitoring, fall 1984, Japanese Beetle Project, Sacramento, 1983-6. Locations of sites are shown in Figure III-1.

	Concentration, ppb (Discharge, µg/sec)		
	Date: 8/30/84	10/16/84	11/7/84
Site	Rainfall: 0.25 cm	1.70 cm	1.65 cm
2	not sampled	3.1 (310)	1.5[a]
6	15 (2300)	7.6 (690)	2.3
12	not sampled	0.4 (1.0)	0.6
14	not sampled	35 (2100)	1.0
15	not sampled	2.5 (200)	1.9
16	not sampled	1.2 (310)	1.9
17	21 (5100)	1.9 (860)	1.8

a Flow rates nor discharge rates could be estimated on 11/7/84.

APPENDIX IV

SPRING 1985 DIAZINON TREATMENT

INTRODUCTION

The treatment area of the spring 1985 program was the same as the fall 1984 program (Figure IV-1). Also the same granular diazinon, Dzn 14G®, was applied to turf, irrigated pastures, fallow gardens and ornamental plantings for all applications. A total of 3310 kg of diazinon was applied between March 1 and May 2, 1985.

Diazinon concentrations were monitored in turf/thatch, soil, air, fruit, and water. For turf/thatch and soil three locations were monitored, two residences and one school (Locations 22, 28, 74). All of these locations were sampled on 1, 5, 9, and 13 days after each application as well as 17 and 21 days following the third and final application. Turf and thatch were combined into one sample and analyzed for dislodgable and internal residue. Soil samples were collected from the 0-2.5, 0-15 and 15-30 cm depths. The three turf/thatch locations were also sampled for air concentrations before during and after the first application. Commodity samples of apricots, berries, cherries, fava beans, loquats, oranges, and peaches were collected at preharvest and harvest intervals. Both surface and ground water were monitored. Surface water samples consisted of background samples and rain runoff samples during the first rain storm. Ground water was sampled from the one well within the treatment area.

RESULTS AND DISCUSSION

Turf/Thatch

Both the dislodgable and total turf/thatch initial residues detected during this treatment were among the highest documented for the entire program (Tables IV-1 and IV-2, Figures IV-2 and IV-3). Dislodgable concentrations on the day after the first application ranged between 110 and 330 mg/m^2, while the total concentrations were 250 to 690 mg/m^2. The high levels are confirmed by the statistical analysis which showed that the the spring 1985 overall concentrations were higher than the fall 1984 concentrations. However, the dissipation pattern was similar. Day 1 concentrations were significantly higher than day 5 concentrations, which were significantly higher than day 9. Also, application 1 had the highest overall concentration, suggesting that no accumulation over applications occurred. Details of the statistical analysis appeas in Appendix VII.

Soil

As with the turf/thatch, initial surface soil concentrations were among the highest found during the entire program (Tables IV-3, IV-4, Figures IV-4 and IV-5). However, the concentrations at the 0-15 and 15-30 cm depths were low, with most of the samples containing no detectable diazinon (Tables IV-5, IV-6, Figures IV-6 and IV-7). With the exception of application 1, dissipation was rapid.

The initial turf/thatch and soil concentrations were both high, and taken together indicate that different application methods may have been used by the Japanese Beetle Project personnel. The average total turf/thatch concentration for application 1, day 1 was 450 mg/m^2, while the average surface soil concentration was 300 mg/m^2. The sum of these two concentrations, 750 mg/m^2, is considerably higher than the 641 mg/m^2 application rate. To determine if diazinon was being applied higher than label rate, a random survey of three additional properties was conducted. These results are shown in Table IV-7. The survey was conducted on the day after the second application and indicated that applications were within the label rate. The turf/thatch and soil concentrations were typical of those documented for other applications and treatments.

Air

Air concentrations associated with the first application were similar to those detected during the fall 1984 treatment (Figure IV-8). The highest concentrations occurred during the application and watering period, while the background concentrations were the lowest.

Fruit

None of the 52 preharvest and harvest fruit samples contained a detectable amount of diazinon (detection limit 0.1 ppm). The sampling periods and number of sites are shown in Table IV-8.

Water

Results of the background and rain runoff sampling from the first rain storm are shown in Table IV-9. The highest concentration, 34 ppb, is within the range found during previous treatments. The estimates of the mass discharge rates seem to be incorrect. The discharges at sites 6 and 12 combined should not be greater than the discharge at site 17. Dissipation of diazinon between the sites may account for the discrepancy in discharges. Disregarding the value at site 17, the total discharge rate would be at least 21 g/hr.

Ground water was sampled once at one well; the sample contained no detectable residue.

Figure IV-1. Diazinon treatment areas, spring 1985. Numbered locations indicate water sampling sites.

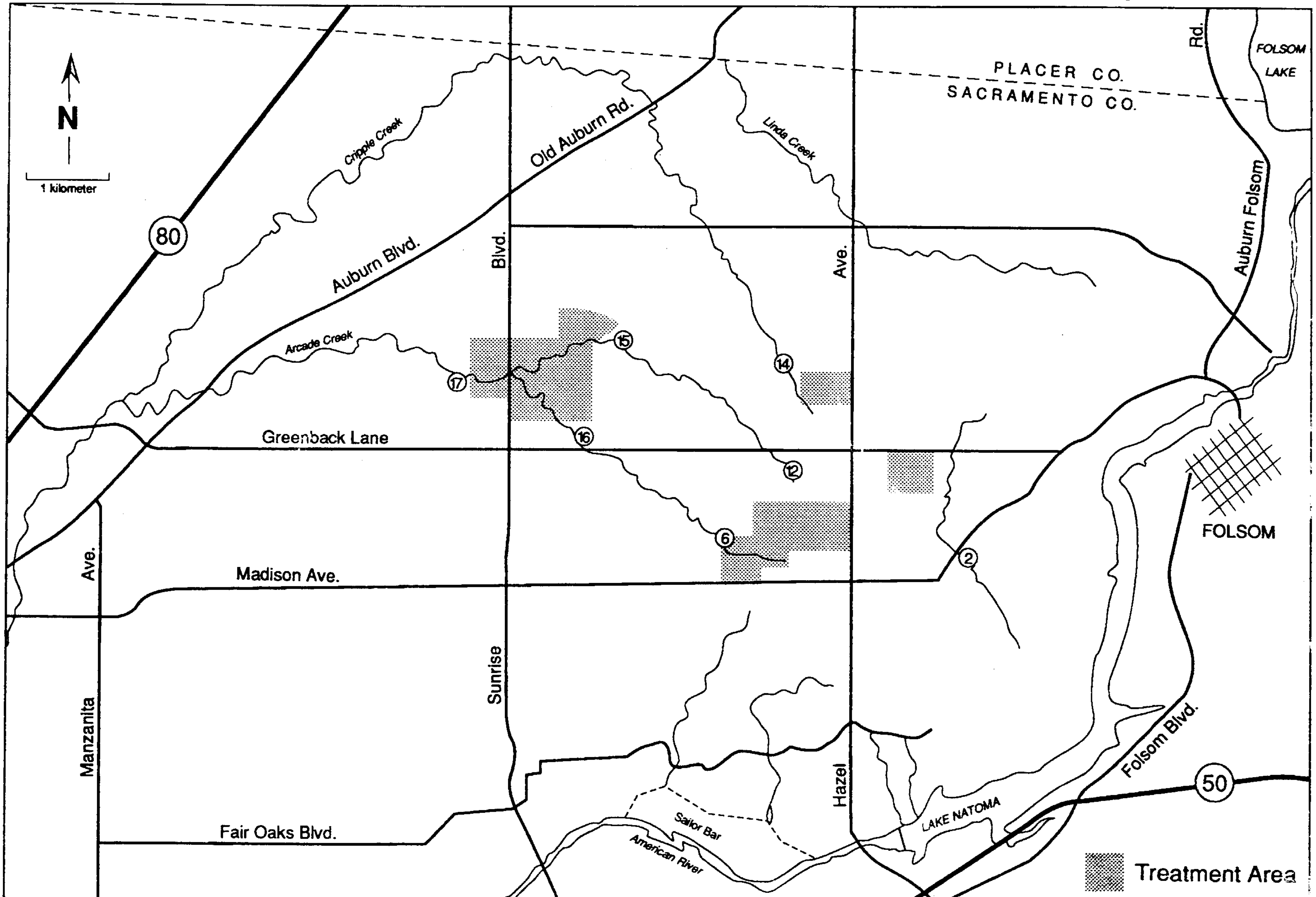


Table IV-1. Summary statistics for dislodgable diazinon concentrations in turf/thatch, spring 1985, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the three site (Locations 22, 28, 74) means. Values below the detection limit are calculated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

		Diazinon Concentration, mg/m^2			
Sampling Day	# of Sites	Mean	Standard Error	Max	Min
Application 1					
Background	3	ND[a]	---	ND	ND
1	3	220	63	330	110
5	3	190	44	240	99
9	2	84	13	97	72
11[a]	1	27	---	27	27
14[a]	1	56	---	56	56
Application 2					
1	2	110	48	156	59
3[b]	1	48	---	48	48
5	3	14	1.3	15	11
9	3	19	8.2	35	9.4
13	1	11	---	11	11
14[b]	1	ND	---	ND	ND
Application 3					
1	3	58	21	83	17
5	3	18	7.6	28	2.9
9	3	16	9.6	34	0.62
13	3	5.1	2.9	10	ND
17	3	15	14	20	ND
21	3	8.8	8.4	26	ND

a ND - None Detected, with a detection limit of approximately 0.4 mg/m^2.

b Sampling days for certain sites were shifted

Table IV-2. Summary statistics for total (dislodgable + internal) diazinon concentrations in turf/thatch, spring 1985, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the three site (Locations 22, 28, 74) means. Values below the detection limit are calculated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

		Diazinon Concentration, mg/m^2			
Sampling Day	# of Sites	Mean	Standard Error	Max	Min
Application 1					
Background	3	ND[a]	---	ND	ND
1	3	450	130	690	250
5	3	440	82	570	290
9	2	210	2.4	210	210
11[b]	1	57	---	57	57
14[b]	1	140	---	140	140
Application 2					
1	2	230	77	300	150
3[b]	1	140	---	140	140
5	3	43	8.8	57	27
9	3	65	24	110	36
13	1	35	---	35	35
14[b]	1	ND	---	ND	ND
Application 3					
1	3	200	88	350	50
5	3	120	54	180	11
9	3	54	32	110	5.9
13	3	26	13	47	ND
17	3	64	57	180	ND
21	3	36	33	100	ND

a ND - None Detected, with a detection limit of approximately 2 mg/m^2.

b Sampling days for certain sites were shifted

Figure IV-2. Dislodgable Diazinon in Turf/Thatch Samples
Spring 1985.

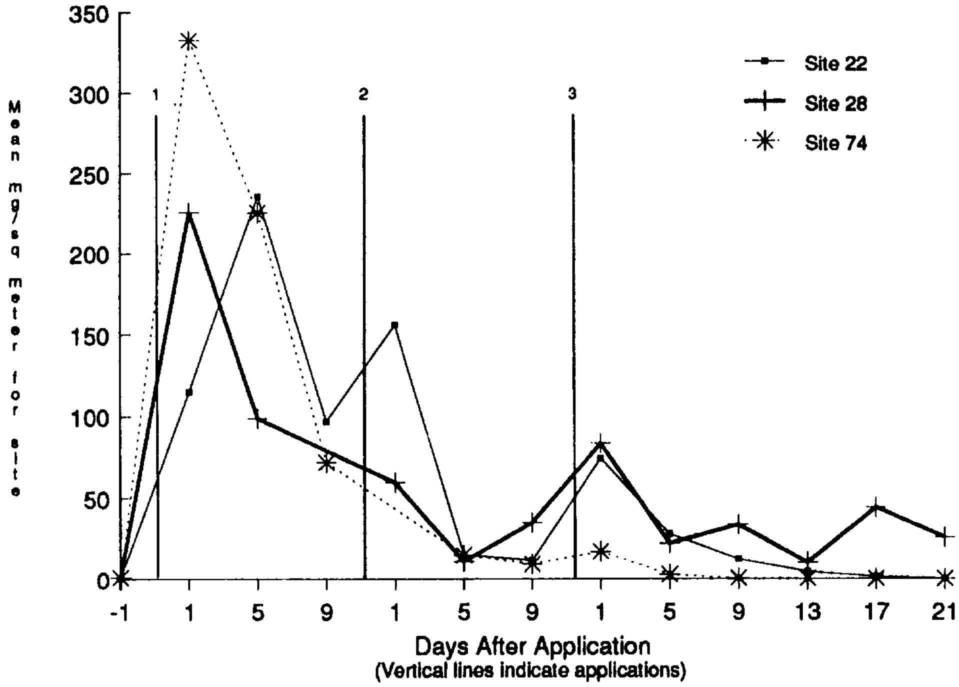


Figure IV-3. Total Diazinon in Turf/Thatch Samples
Spring 1985.

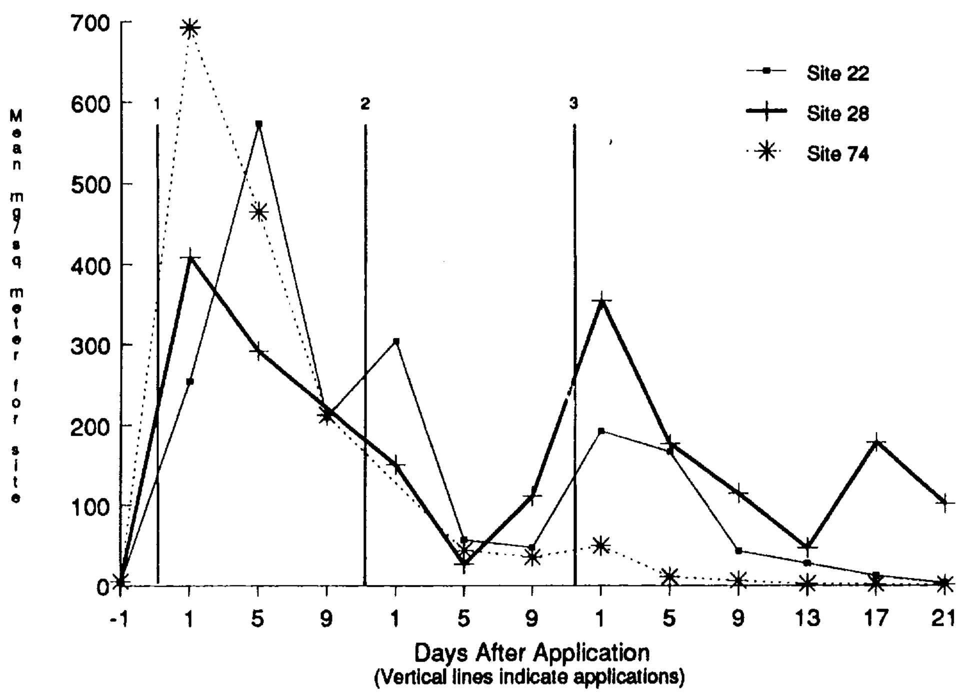


Table IV-3. Summary statistics for diazinon concentrations in soil (0-2.5 cm, mg/m^2), spring 1985, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the three site (Locations 22, 28, 74) means. Values below the detection limit are calculated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

		Diazinon Concentration, mg/m^2			
Sampling Day	# of Sites	Mean	Standard Error	Max	Min
Application 1					
Background	3	ND (1.8)[a]	ND (0.09)	ND (2.0)	ND (1.7)
1	3	300	170	610	12
5	3	300	230	760	25
9	2	120	83	210	41
11[b]	1	46	---	46	46
14[b]	1	290	---	290	290
Application 2					
1	2	190	3.5	190	190
3[b]	1	51	---	51	51
5	3	34	4.1	42	28
9	3	82	26	120	33
13	1	57	---	57	57
14[a]	1	16	---	16	16
Application 3					
1	3	390	90	560	240
5	3	96	56	200	6.2
9	3	130	100	330	ND (1.7)
13	3	63	42	140	3.7
17	3	110	95	300	ND (2.0)
21	3	56	51	160	2.8

a ND - None Detected, with the value indicating 1/2 the detection limit.

b Sampling days for certain sites were shifted

Table IV-4. Summary statistics for diazinon concentrations in soil (0-2.5 cm, ppm), spring 1985, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the three site (Locations 22, 28, 74) means. Values below the detection limit are calculated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

		Diazinon Concentration, ppm			
Sampling Day	# of Sites	Mean	Standard Error	Max	Min
Application 1					
Background	3	ND (0.05)[a]	---	ND (0.05)	ND (0.05)
1	3	8.0	4.9	17	0.32
5	3	9.4	7.0	23	0.87
9	2	3.6	2.2	5.8	1.3
11[b]	1	1.7	---	1.7	1.7
14[b]	1	8.6	---	8.6	8.6
Application 2					
1	2	6.2	0.11	6.2	6.2
3[b]	1	1.7	---	1.7	1.7
5	3	1.1	0.22	1.6	0.83
9	3	3.0	0.98	4.5	1.2
13	1	1.6	---	1.6	1.6
14[b]	1	0.52	---	0.52	0.52
Application 3					
1	3	15	3.2	19	8.7
5	3	3.6	2.4	8.1	0.22
9	3	6.0	5.2	16	ND (0.05)
13	3	2.6	1.8	6.0	0.13
17	3	4.6	4.2	13	ND (0.05)
21	3	2.3	2.1	6.5	0.08

a ND - None Detected, with the value indicating 1/2 the detection limit.

b Sampling days for certain sites were shifted

Figure IV-4. Diazinon in Soil Samples (0-2.5 cm, mg/sq m)
Spring 1985.

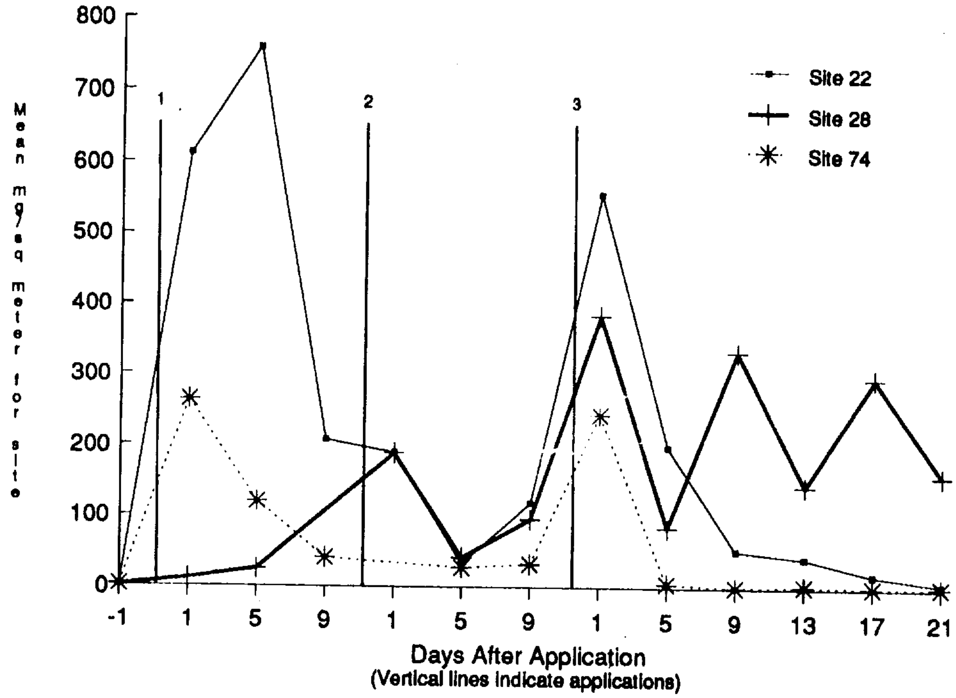


Figure IV-5. Diazinon in Soil Samples (0-2.5 cm, ppm)
Spring 1985.

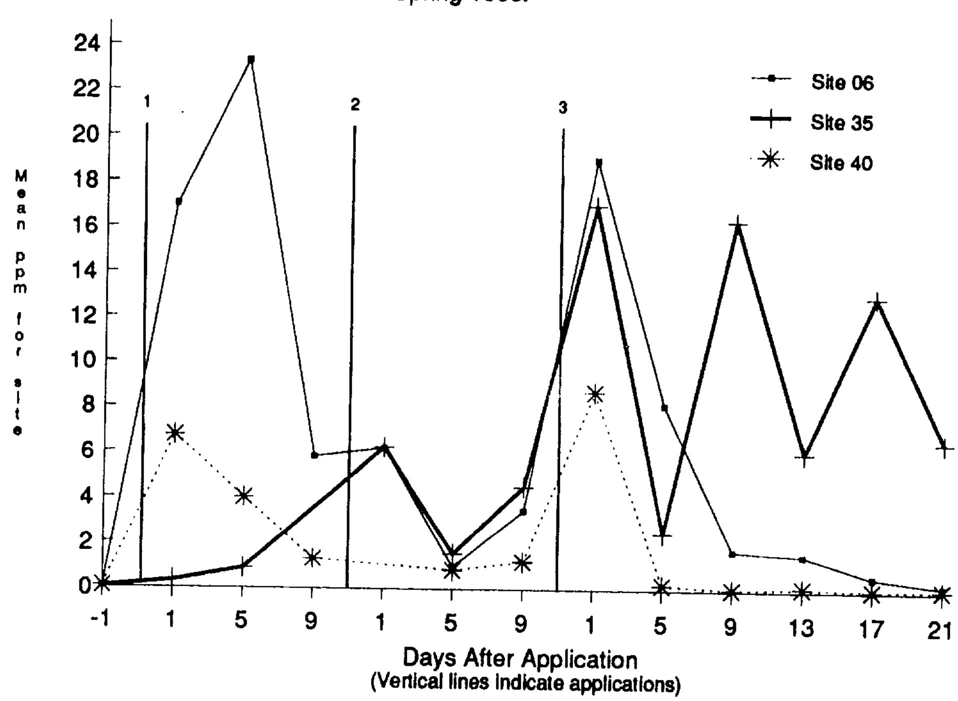


Table IV-5. Summary statistics for diazinon concentrations in soil (0-15 cm, ppm), spring 1985, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the three site (Locations 22, 28, 74) means. Values below the detection limit are calculated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

Sampling Day	# of Sites	Diazinon Concentration, ppm: Mean	Standard Error	Max	Min
Application 1					
Background	3	ND (0.05)[a]	---	ND (0.05)	ND (0.05)
1	3	0.06	0.01	0.07	ND (0.05)
5	3	ND (0.05)	---	ND (0.05)	ND (0.05)
9	2	0.14	0.01	0.15	0.13
11[b]	1	0.13	---	0.13	0.13
14[b]	1	ND (0.05)	---	ND (0.05)	ND (0.05)
Application 2					
1	2	0.48	0.43	0.92	ND (0.05)
3[b]	1	0.35	---	0.35	0.35
5	3	ND (0.05)	---	ND (0.05)	ND (0.05)
9	3	0.11	0.06	0.23	ND (0.05)
13	1	ND (0.05)	---	ND (0.05)	ND (0.05)
14[b]	1	ND (0.05)	---	ND (0.05)	ND (0.05)
Application 3					
1	3	0.07	0.01	0.10	ND (0.05)
5	3	ND (0.05)	---	ND (0.05)	ND (0.05)
9	3	0.08	0.04	0.17	ND (0.05)
13	3	ND (0.05)	---	ND (0.05)	ND (0.05)
17	3	ND (0.05)	---	ND (0.05)	ND (0.05)
21	3	0.09	0.04	0.17	ND (0.05)

a ND - None Detected, with the value indicating 1/2 the detection limit

b Sampling days for certain sites were shifted

Table IV-6. Summary statistics for diazinon concentrations in soil (15-30 cm, ppm), spring 1985, Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated on the three site (Locations 22, 28, 74) means. Values below the detection limit are calculated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

		Diazinon Concentration, ppm			
Sampling Day	# of Sites	Mean	Standard Error	Max	Min
Application 1					
Background	3	ND (0.05)[a]	---	ND (0.05)	ND (0.05)
1	3	ND (0.05)	---	ND (0.05)	ND (0.05)
5	3	ND (0.05)	---	ND (0.05)	ND (0.05)
9	2	0.48	0.43	0.92	ND (0.05)
11[b]	1	ND (0.05)	---	ND (0.05)	ND (0.05)
14[b]	1	ND (0.05)	---	ND (0.05)	ND (0.05)
Application 2					
1	2	ND (0.05)	---	ND (0.05)	ND (0.05)
3[b]	1	ND (0.05)	---	ND (0.05)	ND (0.05)
5	3	ND (0.05)	---	ND (0.05)	ND (0.05)
9	3	ND (0.05)	---	ND (0.05)	ND (0.05)
13	1	ND (0.05)	---	ND (0.05)	ND (0.05)
14[b]	1	ND (0.05)	---	ND (0.05)	ND (0.05)
Application 3					
1	3	ND (0.05)	---	ND (0.05)	ND (0.05)
5	3	ND (0.05)	---	ND (0.05)	ND (0.05)
9	3	0.13	0.08	0.30	ND (0.05)
13	3	0.09	0.04	0.17	ND (0.05)
17	3	ND (0.05)	---	ND (0.05)	ND (0.05)
21	3	ND (0.05)	---	ND (0.05)	ND (0.05)

a ND - None Detected, with the value indicating 1/2 the detection limit

b Sampling days for certain sites were shifted

Figure IV-6. Diazinon in Soil Samples (0-15 cm)
Spring 1985.

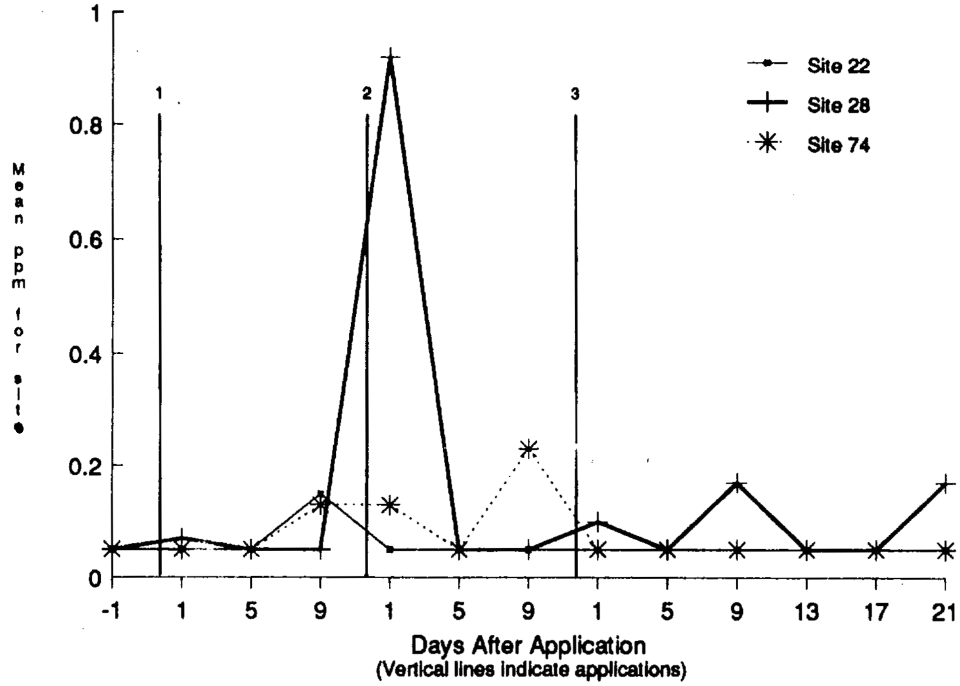


Figure IV-7. Diazinon in Soil Samples (15-30 cm)
Spring 1985.

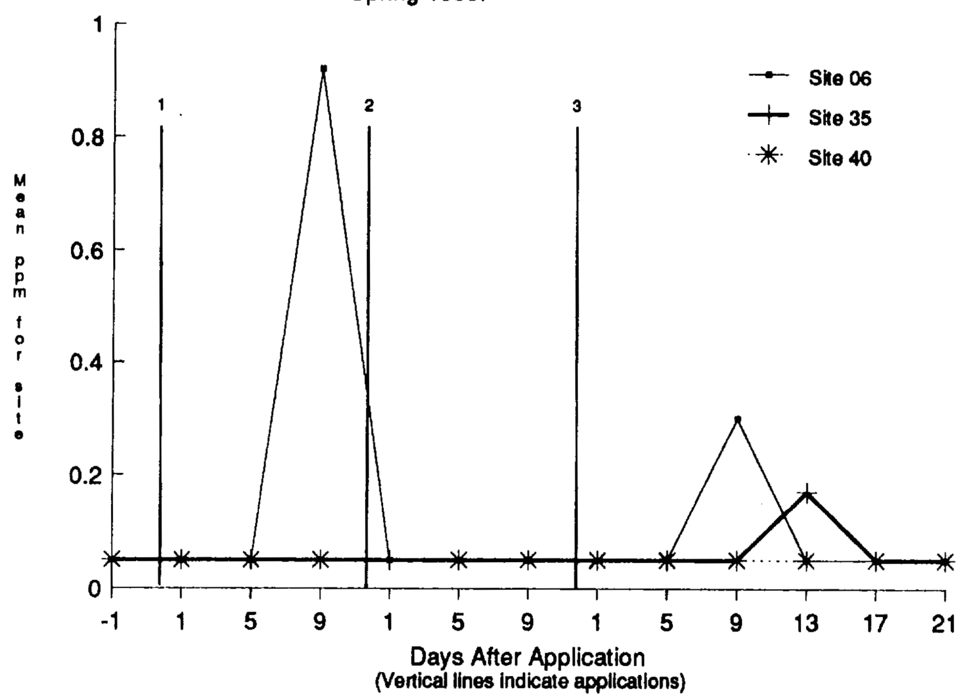


Table IV-7. Results of the turf/thatch and soil (0-2.5 cm) survey, spring 1985, Japanese Beetle Project, Sacramento, 1983-6. Three replicate samples were collected from each of three locations one day after the second application.

	Mean Diazinon Concentration, mg/m^2		
Media	Location 74	Location 78	Location 80
Turf/Thatch (total)	310	120	95
Soil (0-2.5 cm)	96	40	77

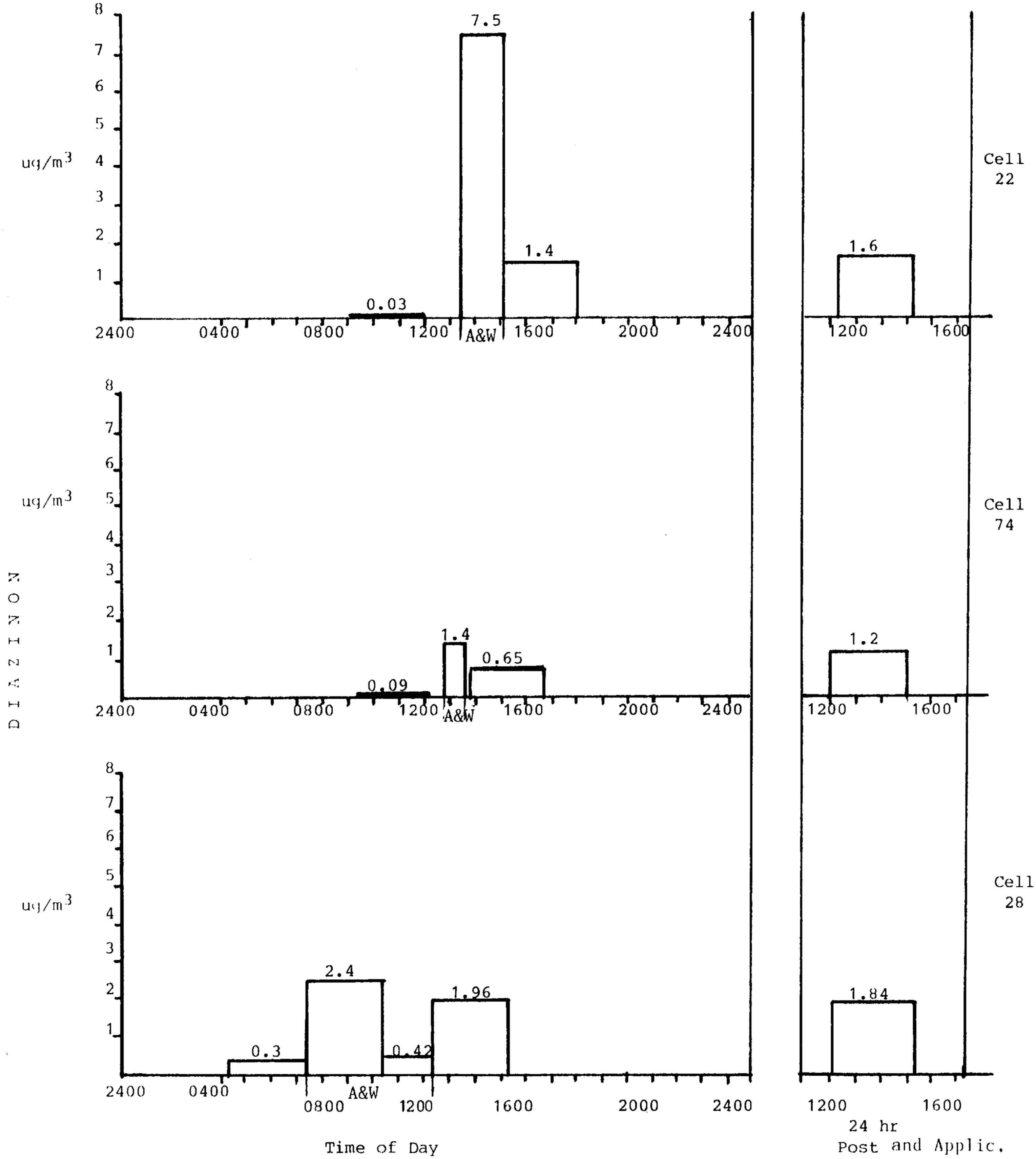


Figure IV-8. Results of the first diazinon application air sampling, spring 1985. Application and watering periods (A&W) are shown on horizontal axis.

Table IV-8. Sampling periods and number of sites for the diazinon fruit sampling, spring 1985, Japanese Beetle Project, Sacramento, 1983-6.

	Number of Properties Sampled	Sampling Period, Days After 1st Application	
		Preharvest	Harvest
Apricots	4	78 - 108	88 - 117
Berries	4	68 - 84	78 - 93
Cherries	5	51 - 60	59 - 72
Fava Beans	1	37	51
Loquats	4	51 - 66	59 - 81
Oranges	4	43 - 50	55 - 62
Peaches	4	92 - 109	100 - 140

Table IV-9. Results of the diazinon background and rain runoff monitoring, spring 1985, Japanese Beetle Project, Sacramento, 1983-6. Locations of sites are shown in Figure IV-1.

		Concentration, ppb (Discharge, μg/sec)	
	Date:	2/28/85	3/26/85
Site	Rainfall:	Background	2.16 cm
2		ND (0)[a]	3.2 (680)
6		ND (0)	34 (5100)
12		0.2 (0.68)	1.0 (6.8)
14		ND (0)	0.1 (--)[b]
15		0.7 (5.2)	2.3 (69)
16		ND (0)	3.9 (--)
17		2.0 (20)	27 (1400)

a ND - None Detected, detection limit 0.1 ppb

b (--) - Flow rates nor discharge rates could be estimated

APPENDIX V

FALL 1985 DIAZINON TREATMENT

INTRODUCTION

The treatment area of the fall 1985 program was reduced from the spring 1984 treatment (Figure V-1). The granular diazinon, Dzn 14G®, was applied to turf, irrigated pastures, fallow gardens and ornamental plantings as in previous treatments. A total of 380 kg of diazinon was applied between August 19 and October 2, 1985.

Diazinon concentrations were monitored in turf/thatch, soil, fruit, and water. For turf/thatch and soil one school (Location 06) was monitored. This location was sampled on 1, 5, 9, and 13 days after each application. Turf and thatch were combined into one sample and analyzed for total residue. Soil was sampled from the 0-2.5 and 0-15 cm depths. Fruit samples of figs and persimmons were collected at preharvest and harvest intervals. Surface water samples consisted of background samples and rain runoff samples during the first two rain storms.

RESULTS AND DISCUSSION

Turf/Thatch

Turf/thatch concentrations were slightly higher, but within the range observed during previous treatments, varying from 13 to 220 mg/m^2 (Table V-1, Figure V-2). Dissipation again was rapid, with concentrations approximately one-tenth of initial levels by Day 13. No accumulation was seen between applications.

Soil

Surface soil concentrations were slightly lower than found during previous treatments, ranging from 20 to 120 mg/m^2 or 0.50 to 4.4 ppm (Table V-1, Figures V-3 and V-4). However, dissipation was slower than earlier treatments. Less watering occurred immediately after application which could account for the higher turf/thatch and lower soil residues.

Soil cores collected from the 0-15 cm depth had concentrations within the range of previous treatments, ranging from nondetectable to 0.22 ppm (Table V-1, Figure V-5). An unusual trend of increasing concentration was found during the second application. However, concentrations were so low that this may just be random variation.

Fruit

None of the fig or persimmon fruit samples contained a detectable amount of diazinon (detection limit 0.1 ppm). The sampling periods and number of sites are shown in Table V-2.

Water

Results of the background and rain runoff sampling from the first two rain storms are shown in Table V-3 . The highest concentration, 5.2 ppb, is within the range found during previous treatments. The estimates of the mass discharge rates were lower than previous treatments, probably because of the reduced amount of diazinon applied. The total mass discharge rates should be represented by the discharge rate at site 17. Assuming this is the case the total discharge for September 17th was 0.79 g/hr. However, the discharge rate at sites 6 and 12 combined is greater than site 17 on September 8th. Disregarding the value of site 17, the total discharge for the September 8th sampling was at least 0.19 g/hr.

Figure V-1. Diazinon treatment areas, fall 1985. Numbered locations indicate water sampling sites.

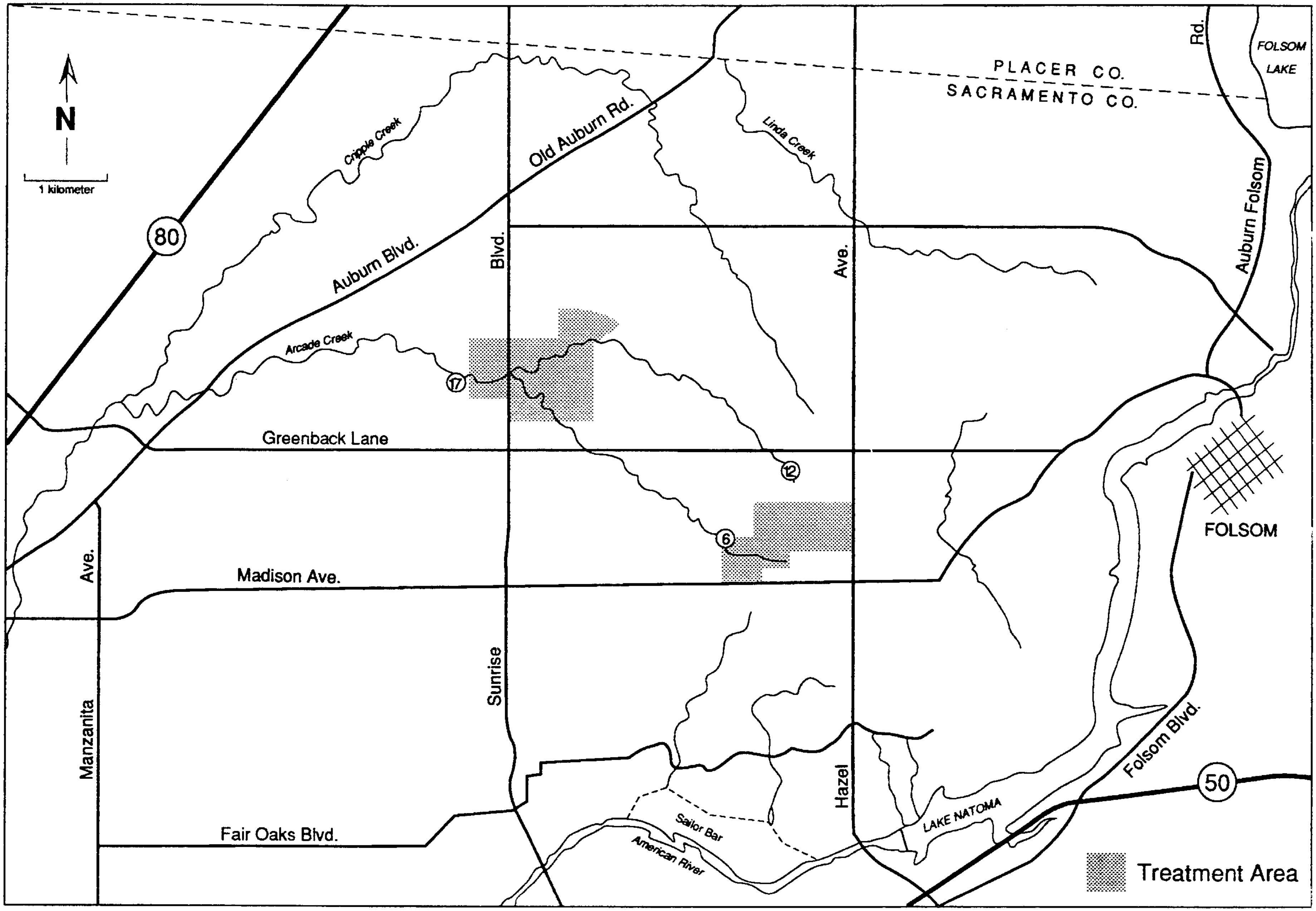


Table V-1. Results of the turf/thatch (dislodgable + internal) and soil (0-2.5 and 0-15 cm) sampling for diazinon, fall 1985, Japanese Beetle Project, Sacramento, 1983-6. Each value is the mean of three replicate samples from one site (Location 06). Samples below the detection limit are calculated as 1/2 the detection limit.

Sampling Day	Diazinon Concentration, mg/m^2		Diazinon Concentration, ppm	
	Turf/Thatch	Soil (0-2.5)	Soil (0-2.5)	Soil (0-15)
Application 1				
Background	ND (1.0)[a]	ND (1.7)	ND (0.05)	ND (0.05)
1	220	66	1.9	0.07
5	110	80	3.1	ND (0.05)
9	74	26	0.63	ND (0.05)
Application 2				
1	170	120	3.1	ND (0.05)
5	140	54	1.6	0.10
9	160	120	4.4	0.10
13	22	20	0.67	0.22
Application 3				
1	130	45	1.8	0.12
5	110	74	2.6	0.13
9	53	15	0.50	ND (0.05)
13	13	23	0.87	ND (0.05)

a ND - None Detected, with the value indicating 1/2 the detection limit

Figure V-2. Total Diazinon in Turf/Thatch Samples
Fall 1985.

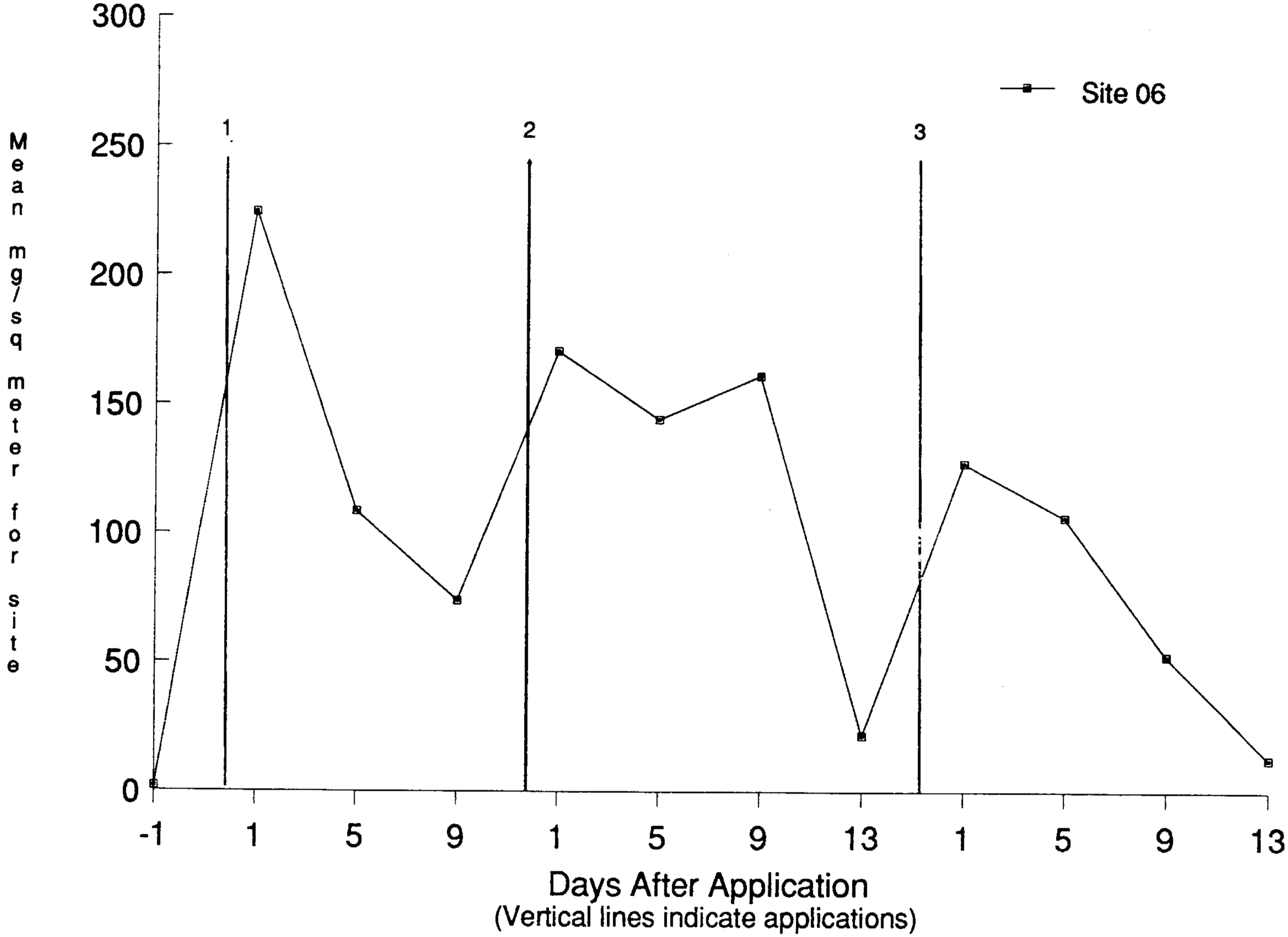


Figure V-3. Diazinon in Soil Samples (0-2.5 cm, mg/sq m)
Fall 1985.

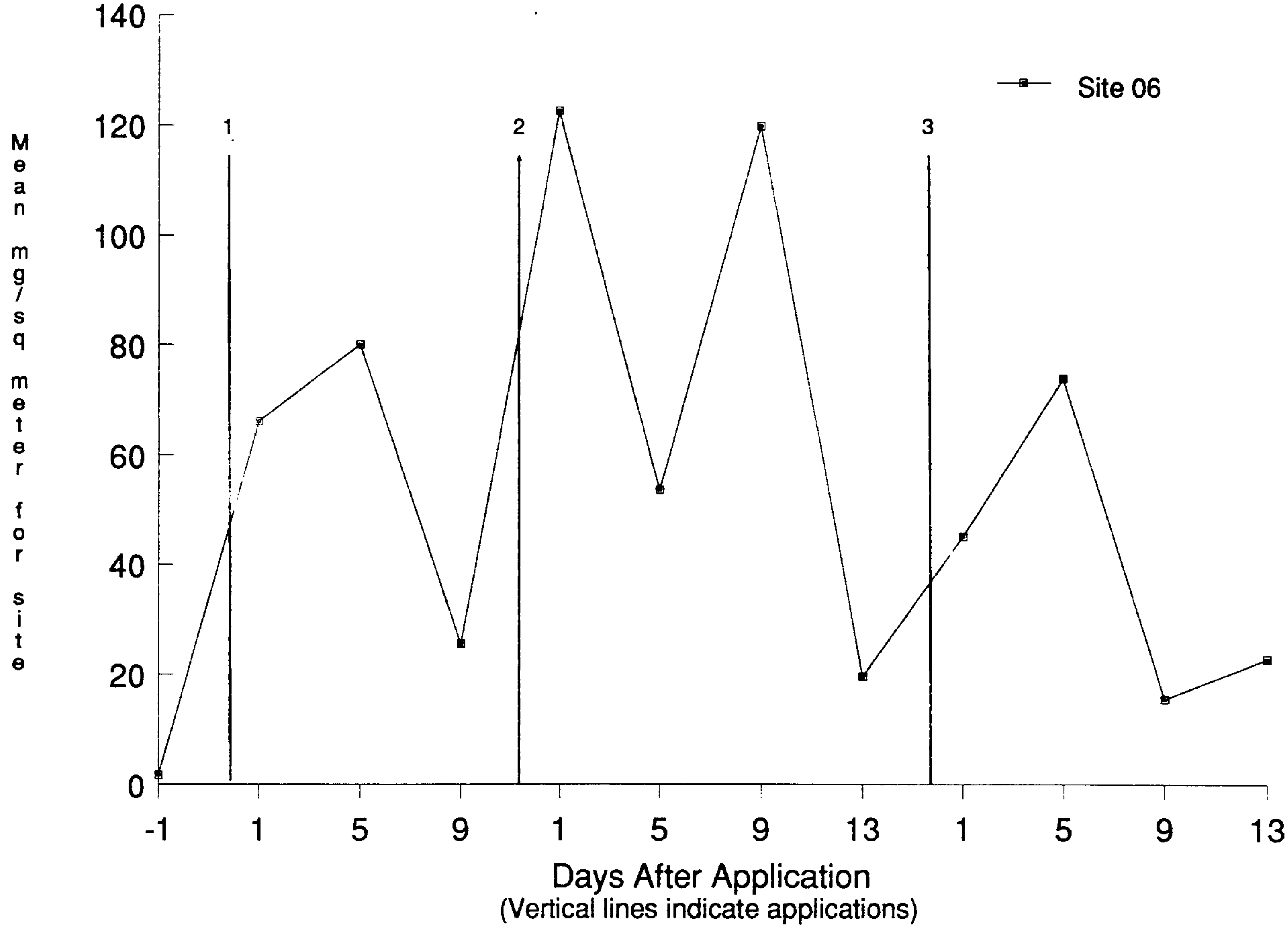


Figure V-4. Diazinon in Soil Samples (0-2.5 cm, ppm)
Fall 1985.

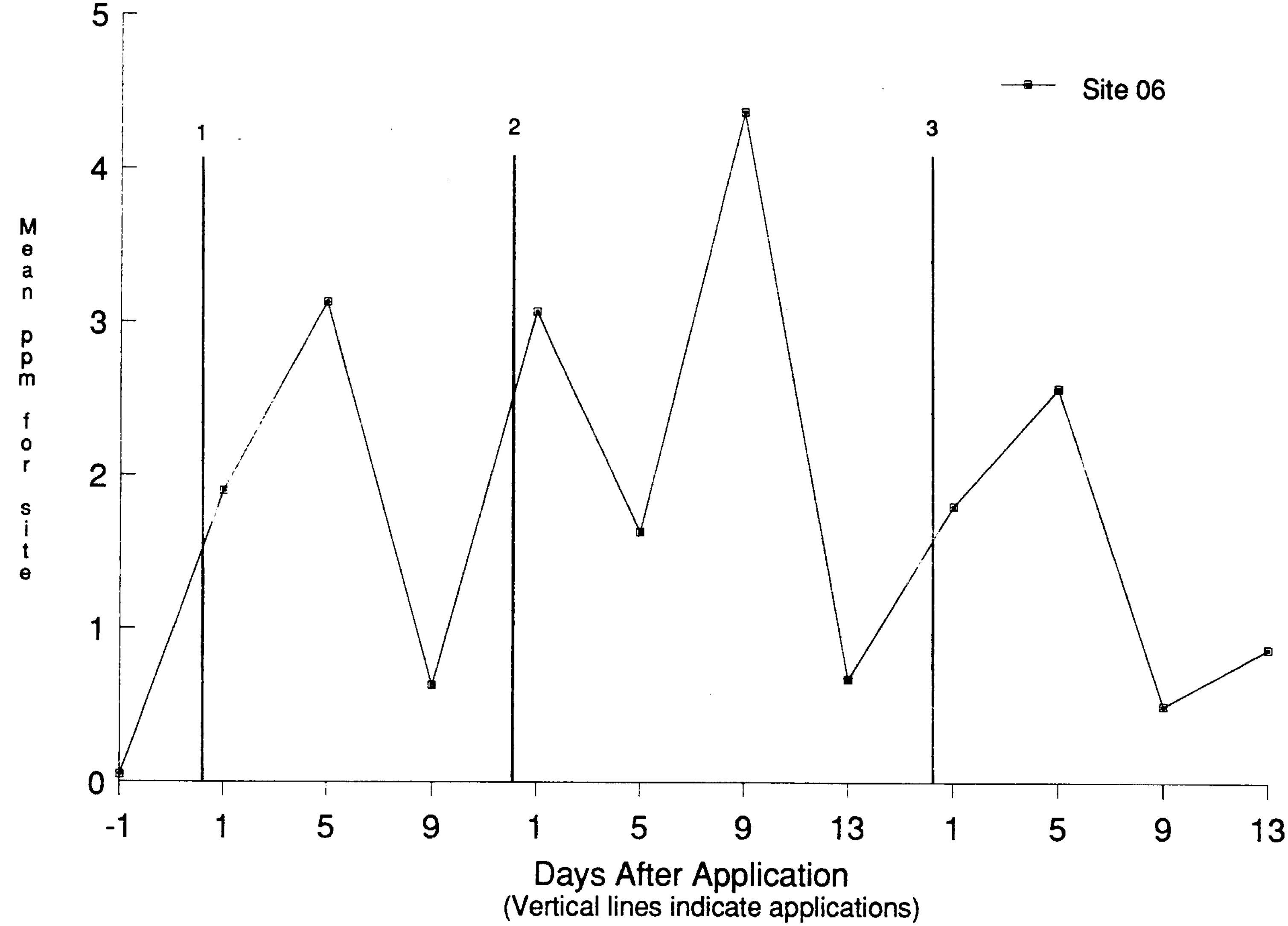


Figure V-5. Diazinon in Soil Samples (0-15 cm)
Fall 1985.

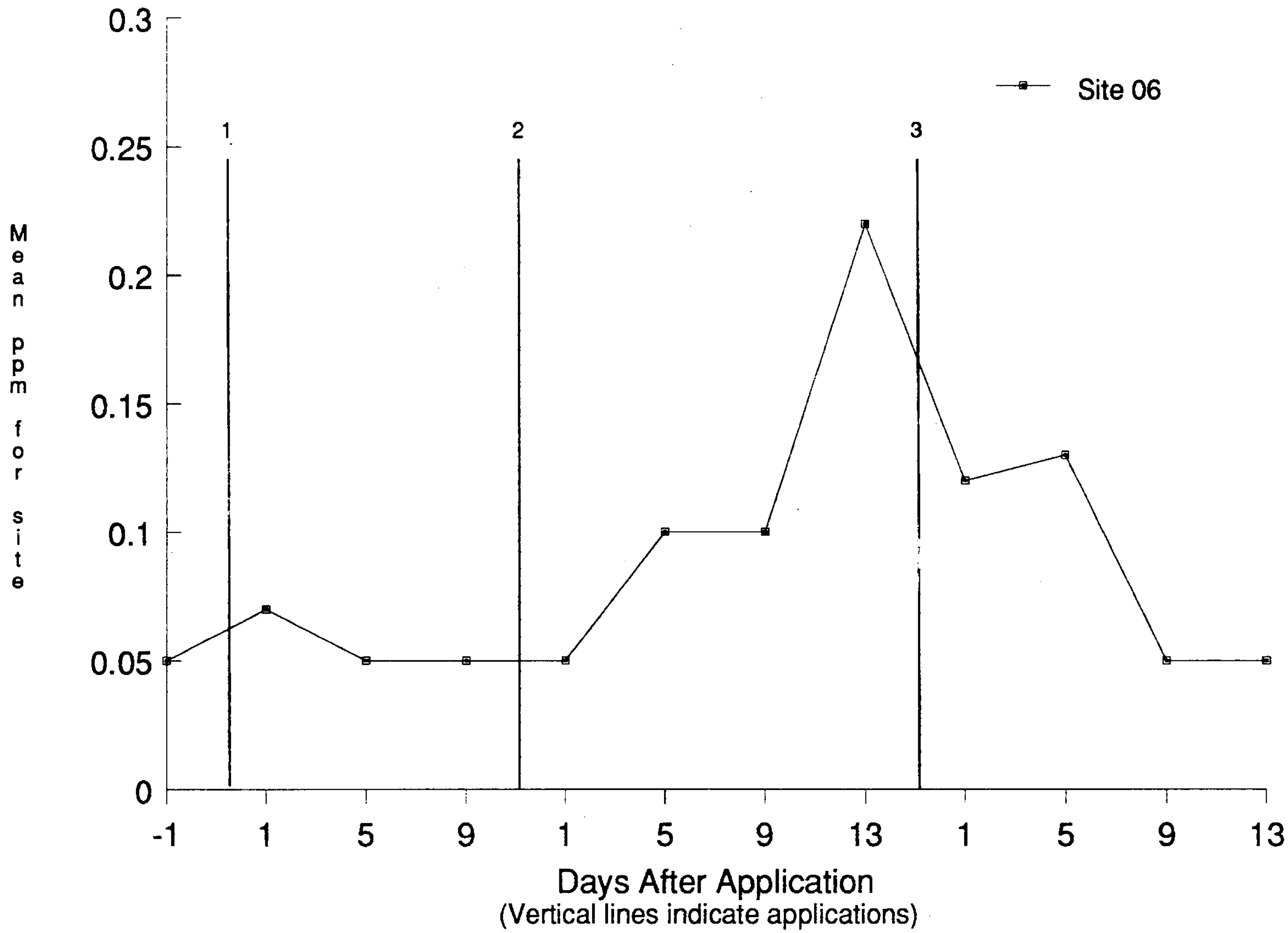


Table V-2. Sampling periods and number of sites for the diazinon fruit sampling, fall 1985, Japanese Beetle Project, Sacramento, 1983-6.

	Number of Properties Sampled	Sampling Period, Days After 1st Application	
		Preharvest	Harvest
Fig	3	16 - 23	29 - 36
Persimmon	1	36	69

Table V-3. Results of the diazinon rain runoff monitoring, fall 1985, Japanese Beetle Project, Sacramento, 1983-6. Locations of sites are shown in Figure V-1.

		Concentration, ppb (Discharge, µg/sec)		
	Date:	8/16/85	9/8/85	9/17/85
Site	Rainfall:	Background	0.28 cm	unknown
6		ND (0)[a]	1.6 (51)	3.4 (20)
12		0.1 (0.26)	0.2 (1.1)	ND (0)
17		0.4 (12)	1.1 (31))	5.2 (220)

a ND - None Detected, detection limit 0.1 ppb

APPENDIX VI

SPRING 1986 DIAZINON TREATMENT

INTRODUCTION

The treatment area of the spring 1986 program was reduced from the fall 1985 treatment (Figure VI-1). Granular diazinon, Dzn 14G®, was applied to turf, irrigated pastures, fallow gardens and ornamental plantings as in previous treatments. A total of 191 kg of diazinon was applied between March 3 and April 21, 1986.

Diazinon concentrations were monitored in turf/thatch, soil, and water. For turf/thatch and soil one residential property (Location 81) was monitored. This location was sampled on 1, 5, 9, and 13 days after each application. Turf and thatch were combined into one sample and analyzed for total residue. Soil samples were collected from the 0-2.5 and 0-15 cm depths. Surface water samples consisted of background samples and rain runoff samples during the first two rain storms.

RESULTS AND DISCUSSION

Turf/Thatch

With the exception of the samples collected the day after the third application, concentrations were typical of those found during previous treatments (Table VI-1, Figure VI-2). The 490 mg/m^2 detected on the day after the third application was the highest mean value for any site sampled. This high value was probably due to less watering at this site, since the corresponding soil samples were among the lowest concentrations found the day after an application.

Soil

With the exception of the samples collected the day after the third application, concentrations were typical of those found during previous treaments (Table VI-1, Figures VI-3, VI-4, VI-5). As mentioned earlier, the 42 mg/m^2 found the day after the third application is among the lowest found on the day after application.

Water

Surface water samples were collected from one site (site 6) shown in Figure VI-1. Background concentration at this site was 1.1 ppb, with a discharge rate of 9.4 µg/sec. The first rain runoff sample was collected on March 7, 1986 after 0.58 cm of rainfall. The concentration was 2.5 ppb, with a discharge rate of 49 µg/sec. The second rain runoff sample was collected on April 5, 1986 after 0.38 cm of rainfall. The concentration was 4.2 ppb, with a discharge rate of 550 µg/sec.

Figure VI-1. Diazinon treatment area, spring 1986. Numbered locations indicate water sampling sites.

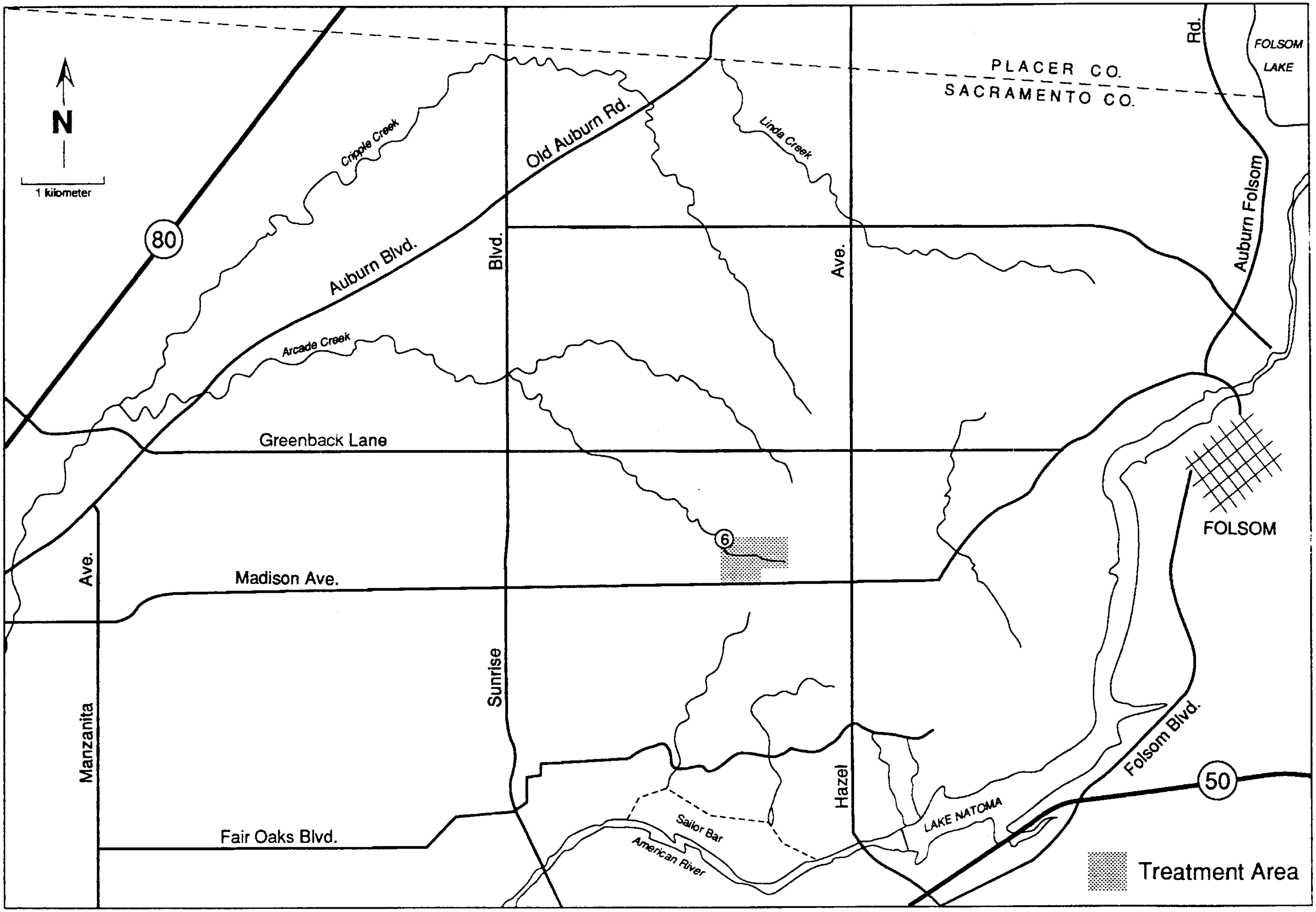


Table VI-1. Results of the turf/thatch (dislodgable + internal) and soil (0-2.5 and 0-15 cm) sampling for diazinon, spring 1986, Japanese Beetle Project, Sacramento, 1983-6. Each value is the mean of three replicate samples from one site (Location 81). Samples below the detection limit are calculated as 1/2 the detection limit.

Sampling Day	Diazinon Concentration, mg/m^2		Diazinon Concentration, ppm	
	Turf/Thatch	Soil (0-2.5)	Soil (0-2.5)	Soil (0-15)
Application 1				
Background	ND (1.0)[a]	ND (1.9)	ND (0.05)	ND (0.05)
1	230	200	4.5	ND (0.05)
5	41	160	4.7	0.53
9	29	72	1.8	0.47
13	5.8	18	0.47	ND (0.05)
Application 2				
1	93	140	3.7	0.15
5	94	39	0.90	0.15
9	68	ND (1.7)	ND (0.05)	0.50
13	26	4.0	0.10	ND (0.05)
Application 3				
1	490	42	1.1	ND (0.05)
5	77	140	4.8	ND (0.05)
9	15	150	4.6	ND (0.05)
13	5.4	ND (2.1)	ND (0.05)	ND (0.05)

a ND - None Detected, with the value indicating 1/2 the detection limit

Figure VI-2. Total Diazinon in Turf/Thatch Samples
Spring 1986.

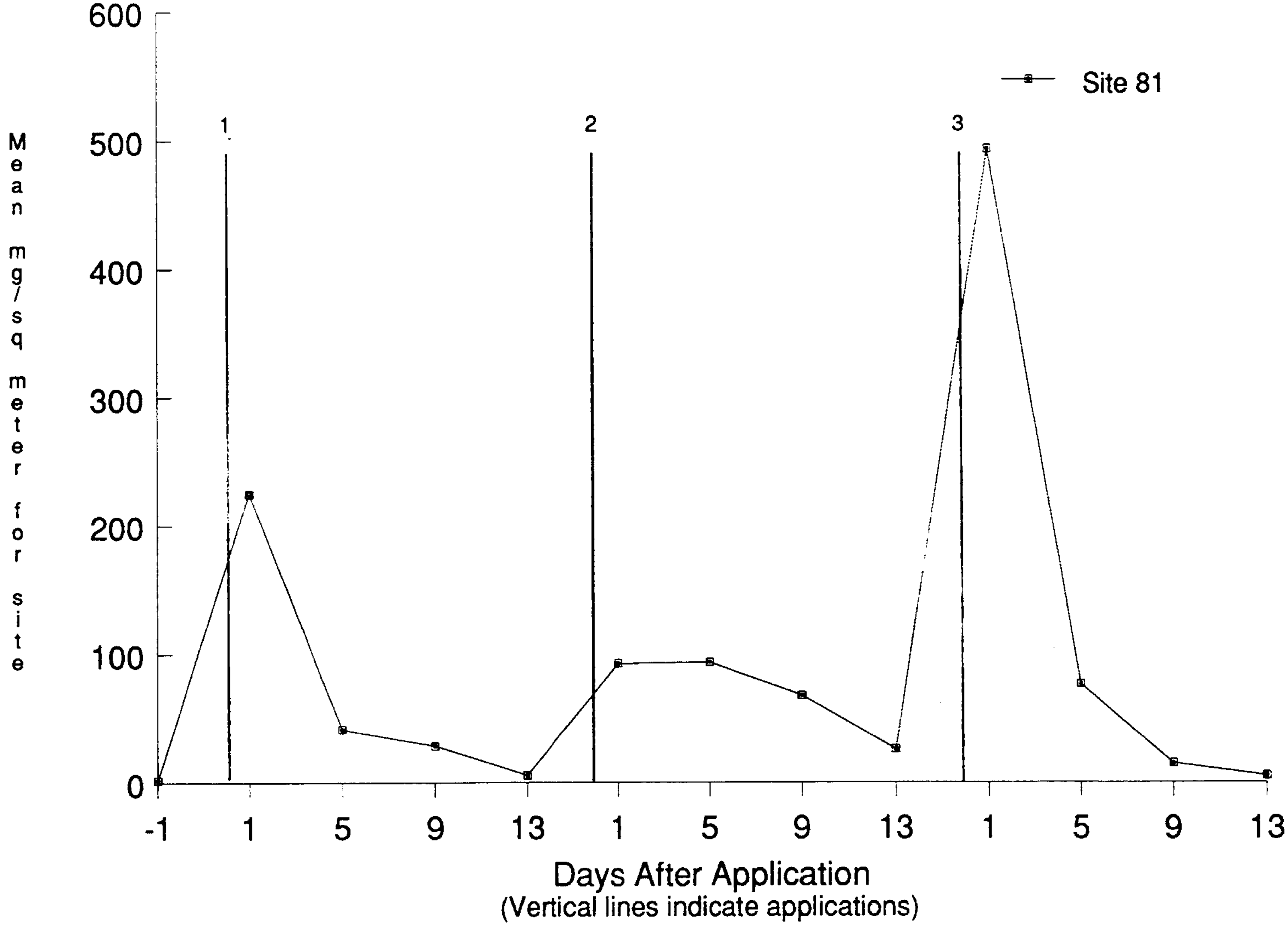


Figure VI-3. Diazinon in Soil Samples (0-2.5 cm, mg/sq m)
Spring 1986.

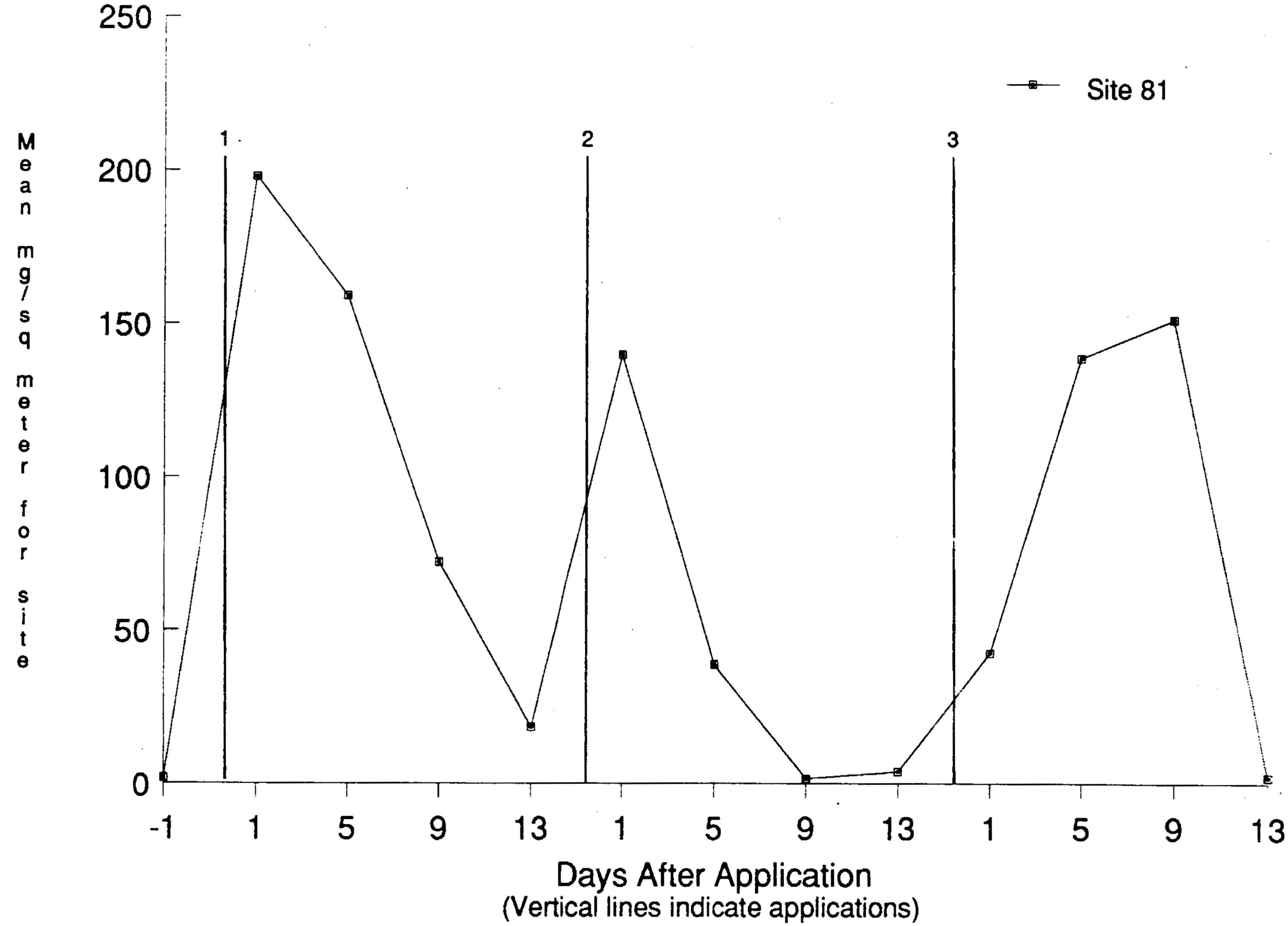


Figure VI-4. Diazinon in Soil Samples (0-2.5 cm, ppm)
Spring 1986.

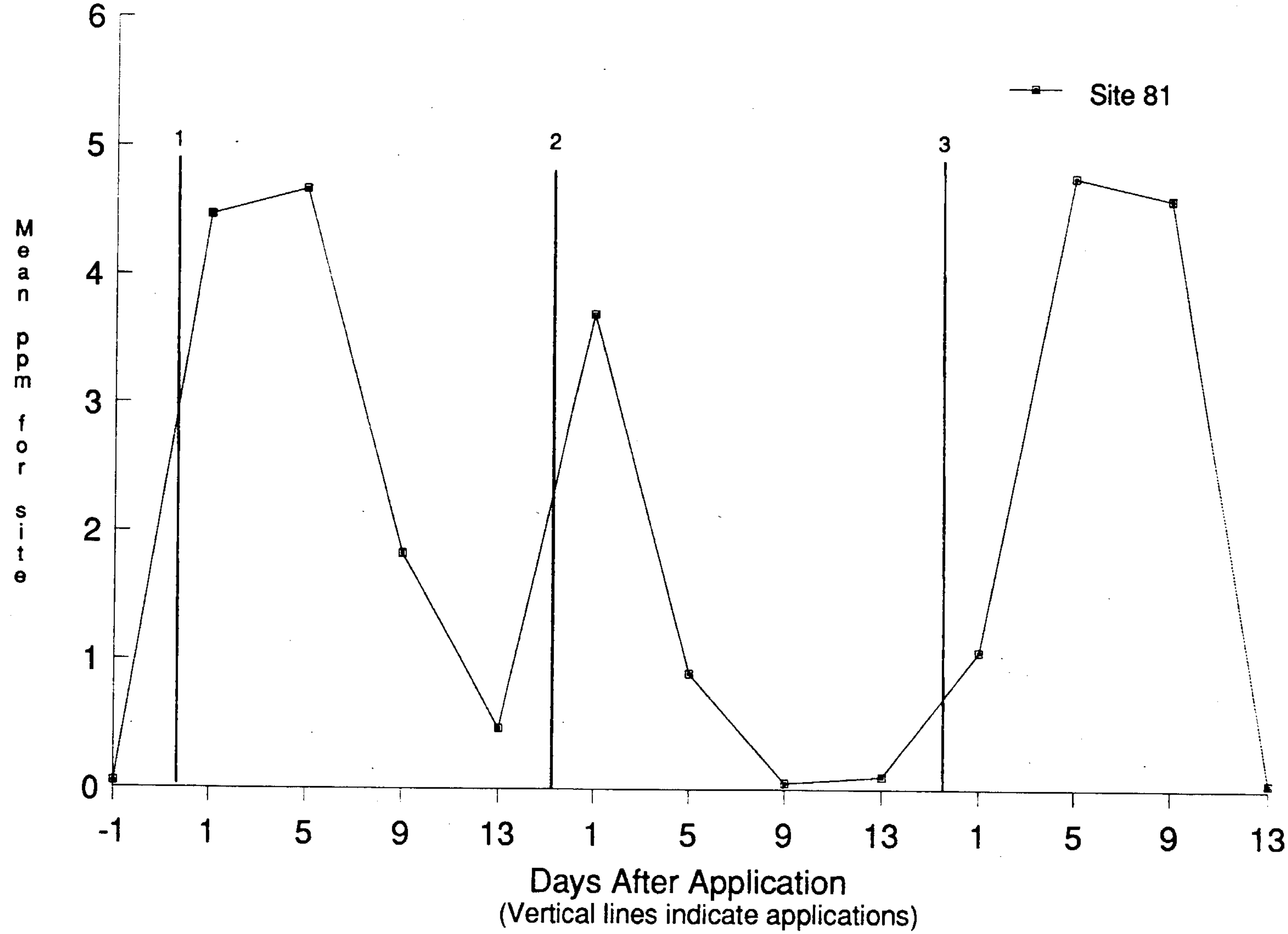
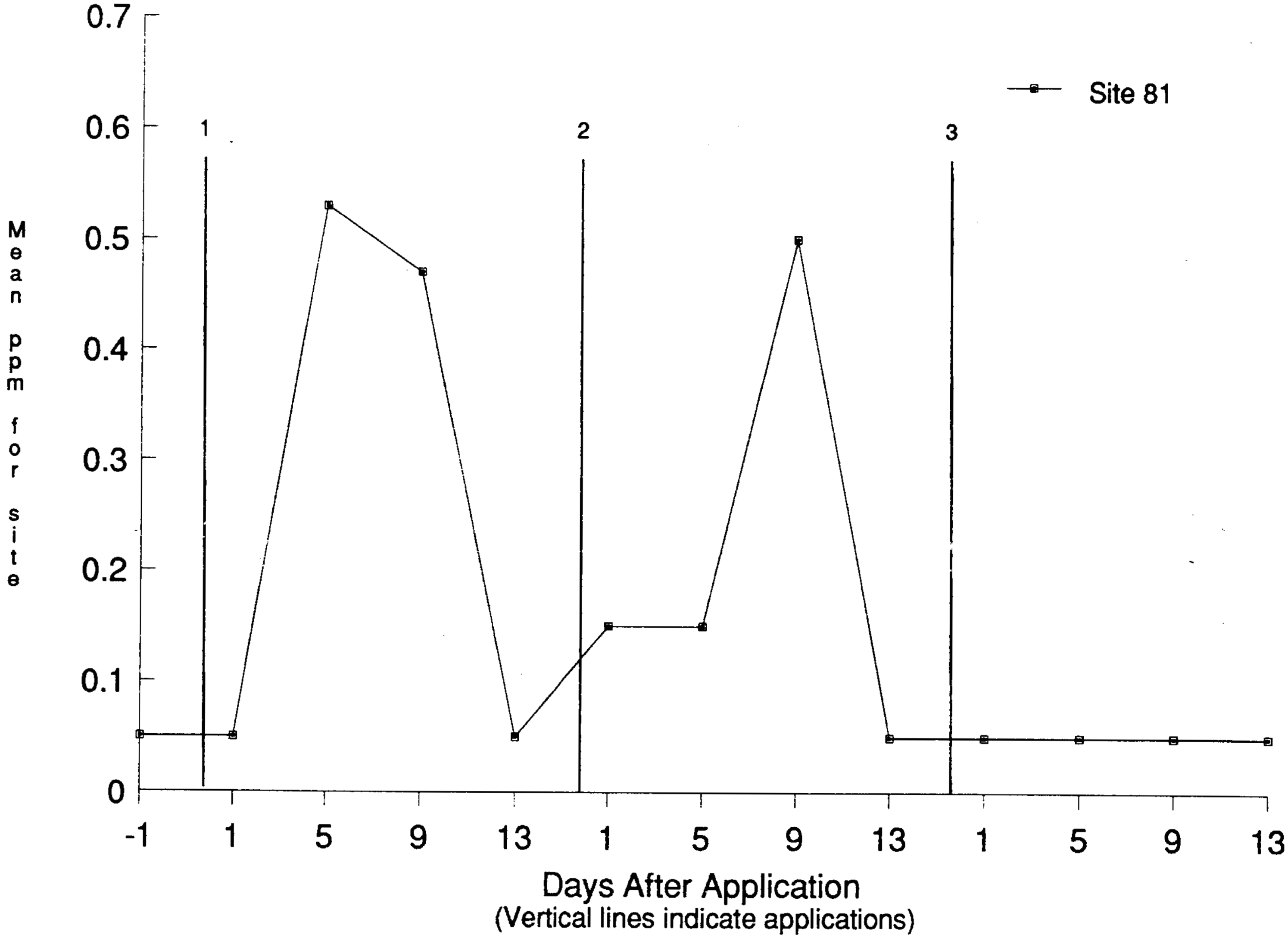


Figure VI-5. Diazinon in Soil Samples (0-15 cm)
Spring 1986.



APPENDIX VII

TURF/THATCH AND SOIL STATISITICAL ANALYSIS

The turf/thatch and soil data were summarized by determining the mean for each site and sampling date, and then calculating a grand mean from the site means for each treatment. The standard error of the grand means were calculated using Formula 10.15 in Cochran (1977), which takes into account the two-stage nature of the sampling.

Turf/thatch

The two largest treatments, fall 1984 and spring 1985, had monitoring data collected for multiple sites on the same numbers of days post application. These data were subjected to a three-way analysis of variance (ANOVA) with sites as replicates, application number and days post application as repeated factors, and treatment as the third ("between") factor. Only days 1, 5 and 9 were included in the ANOVA since day 13 was sampled inconsistently in spring 1985. The pattern of residuals supported the assumption of lognormally distributed concentrations; therefore, the natural log of concentration (expressed as mg/m^2) was used as the dependent variable in the ANOVA.

Results of the ANOVA on total diazinon in turf (Table VII-1) supported the impression given by graphical presentation of the data (Figure III-2 and IV-2) that dissipation, the change in concentration over days, varied considerably between sites, and that within sites it varied over applications. This is indicated by the significant interactions of sites with day, application and day by application. Nonetheless, there were significant overall effects of day, application and treatment that emerged above the variability of individual sites. Table 4 gives the overall means by day, application and treatment. The mean for day 1 (averaging over all three applications and both treatments) was significantly higher than day 5, which was significantly higher than day 9. The pattern among applications was for application 1 to have the highest overall level, application 2 the lowest, with application 3 intermediate between 1 and 2. Thus, the data present no evidence for an accumulation of material from the first to the third applications. Spring 1985 had a higher overall level of diazinon than did fall 1984. The higher level in spring 1985 was probably due to a higher rate of application, rather than either to a build-up of material from multiple treatments, or to a slower rate of dissipation in spring 1985. The lack of any positive findings in the background samples taken prior to application 1 of each treatment indicates that no build-up of material occurred, while the non-significance of the day by treatment and day by treatment by application interactions indicates that the spring 1985 dissipation rate was not slower. It must be noted, however, that individual sites did vary significantly from the overall patterns.

Two secondary ANOVA's were done to examine the levels of diazinon on day 13 and beyond. In fall 1984, samples were collected from each site on day 13 after every application. Thus, an ANOVA with days and applications as treatment effects was conducted. This ANOVA included days 1, 5, 9 and 13, and applications 1, 2 and 3 of the fall 1984 data. The results are given in Table VII-2. Again there were significant interactions of sites with the other factors, indicating that some sites varied from the overall pattern.

However, there was a significant overall effect of day, with days 1 and 5 being significantly higher than days 9 and 13. This was true for all applications. The other secondary ANOVA explored effects only at application 3, comparing fall 1984 and spring 1985, and including days 1, 5, 9, 13, 17 and 21 (the additional days were sampled only after the third and last application each year). The results are given in Table VII-3. This time the difference between the two treatments was not significant. The day effect was significant; days 1 and 5 were significantly higher than days 9, 13 and 17 (which were not significantly different from each other); the difference between day 9 and day 21 was significant, although days 13 and 17 were not different from day 21.

In both fall 1985 and spring 1986, only one site was monitored, so these treatments could not be analyzed with the fall 1984 and spring 1985 data. However, each one was analyzed separately using a day by application ANOVA, and the results were similar to those for fall 1984 and spring 1985. In both years, only the day effect was significant, indicating that the change in diazinon over days was the same for all applications. There was significant decline in mean diazinon level from day 1 to day 9 (and in spring 1986 there was further significant decline from day 9 to day 13).

Taken together, the results of the ANOVA's suggest that significantly more diazinon was applied in the first application than in the second or third in both fall 1984 and spring 1985, and that more material was applied in every application in spring 1985 than in fall 1984. They suggest that significant dissipation of diazinon in turf occurred from day 1 to day 21, with the greatest amount usually occurring between days 5 and 9, and that most of the dissipation had taken place by day 9. This overall pattern describes all three applications for every treatment, although individual sites differed significantly from the overall pattern.

The dislodgable component of diazinon in turf was not sampled consistently in fall 1984, and not at all in fall 1985 or spring 1986. Thus only the analysis comparing fall 1984 to spring 1985 for application 3 was done for dislodgable diazinon. A treatment by day ANOVA using sites as replicates and including days 1, 5, 9, 13 and 17 (day 21 was excluded since all fall 1984 samples were non-detects) revealed significant variability among sites (Table VII-4). Nonetheless, there was a significant effect of day. The overall day means are given in Table 5. Overall, day 1 was significantly higher then day 5, which was significantly higher than day 9. Although there was a slight increase from day 13 to day 17, the means of days 9, 13 and 17 were not significantly different, and as noted above, by day 21 most of the samples were non-detects. There was no overall difference between the two treatments, nor was there a difference in the change over days between the two treatments. Thus, although the amount of dislodgable diazinon was smaller than the total amount, the pattern of dissipation was similar.

Soil

The data on diazinon concentration in surface soil (0-2.5 cm in depth) for fall 1984 and spring 1985 were subjected to the same three-way ANOVA as the turf data, with sites as replicates, application number and days post application as repeated factors, and treatment as the third ("between") factor. Only days 1, 5 and 9 were included in the ANOVA since day 13 was sampled inconsistently in spring 1985. The pattern of residuals supported the assumption of lognormally distributed concentrations; therefore, the natural log of concentration (expressed as mg/m^2) was used as the dependent variable in the ANOVA. The 0-15 and 15-30 cm soil samples were not subjected to ANOVA because of the lack of variability, due to the fact that the major part of the samples were near or below the detection limit.

Results of the ANOVA on diazinon in surface soil (Table VII-5) supported the impression given by graphical presentation of the data (Figure III-3 and IV-3) that dissipation in surface soil, as in turf, varied considerably between sites, and that within sites it varied over applications. This is indicated by the significant interactions of sites with day, application and day by application. Nonetheless, there was a significant main effect of day, and a marginally significant ($p=.052$) day by treatment interaction that emerged above the variability of individual sites. Table 9 gives the overall means by day for each treatment. In fall 1984 the mean for day 1 (averaging over all three applications) was significantly higher than day 5, which was significantly higher than day 9. In spring 1985, day 1 was significantly higher than day 5, but there was a non-significant decrease from day 5 to day 9. Thus while the percent decrease from day 1 to day 5 was very similar for fall 1984 and spring 1985 (about 50%), the decrease from day 5 to day 9 increased to about 70% in fall 1984 but decreased to about 24% in spring 1985. And, although the overall effect of treatment was non-significant, spring 1985 was higher than fall 1984 on all three days, with the differences being significant on days 1 and 9. It must be noted, however, that individual sites did vary significantly from the overall patterns.

Two secondary ANOVA's were done to examine the levels of diazinon on day 13 and beyond. In Fall 1984, samples were collected from each site on day 13 after every application. Thus, a day by application ANOVA including days 1, 5, 9 and 13, and applications 1, 2 and 3 could done on the fall 1984 data. The results are given in Table VII-6. Again there were significant interactions of sites with the other factors, indicating that some sites varied from the overall pattern. However, there were significant overall effects of day and application: day 1 was significantly higher than day 5, which was significantly higher than days 9 and 13, which did not differ significantly from each other; application 1 was significantly higher than applications 2 and 3, which were not significantly different from each other, the same pattern seen in the turf data. The significant application effect is inconsistent with the results of the first ANOVA; it should have been reflected in either a significant overall application effect or a significant treatment by application interaction in the first ANOVA. Examination of means by application for fall 1984 and spring 1985 combined and separately revealed the same pattern seen in fall 1984 alone (that is, application 1 greater than application 3 greater than application 2). The main effect of application was close to significance (p= .104) in the first ANOVA; thus the same relationship between applications was present in both fall 1984 and spring 1985, but it reached statistical significance only in fall 1984. The other secondary ANOVA looked at application 3 only, comparing fall 1984 and spring 1985, and looking at days 1, 5, 9, 13, and 17 (the additional days were sampled only after the third and last application each year). Day 21 was not included in the analysis since all samples in fall 1984 were below the detection limit. The results are given in Table VII-7. Only the main effect of day was significant: day 1 was significantly higher than days 5 and 9; day 5 was significantly higher than days 9, 13 and 17 (which were not significantly different from each other).

In both fall 1985 and spring 1986, only one site was monitored, so these treatments could not be analyzed with the fall 1984 and spring 1985 data. However, each one was analyzed separately using a day by application ANOVA. The results were somewhat different than those for fall 1984 and spring 1985. In both years, the application by day effect was significant, indicating that the change in diazinon over days was different for different applications. In fall 1985, applications 1 and 3 were almost identical: diazinon concentration increased slightly from day 1 to day 5, then decreased substantially from day 5 to day 9. However, with application 2, diazinon decreased from day 1 to day 5, then increased by day 9 to the same level as day 1. In spring 1986, applications 1 and 2 were similar: diazinon decreased each day from day 1 to day 13. At application 3, however, the level increased to day 5, was virtually unchanged from day to day 9, then decreased at day 13. It is not surprising that these sites did not conform to the overall patterns seen in fall 1984 and spring 1985, since in those treatments there were significant departures of individual sites from the overall patterns. The fall 1985 (site 6) and spring 1986 (site 81) results can be interpreted as examples of that site variability.

Taken together, the results of the ANOVA's suggest that although the same patterns occurred in surface soil as in turf, they were weaker, in some cases not statistically significant. Spring 1985 had a higher overall level of diazinon than fall 1984, but this difference was not significant. Similarly, as in the turf, application 1 was higher than application 3, which was higher than application 2, but this difference was only statistically significant in fall 1984. The dissipation of diazinon over days was somewhat less clear than in the turf, but was similar: taking all applications together, there was significant decrease from day 1 to day 5, and from day 5 to day 9 in fall 1984 but not in spring 1985. Again, most dissipation had occurred by day 9.

Results of the subsurface soil samples (from 0-15 and 15-30 cm depth) were not analyzed statistically. These data were not suitable for ANOVA because the variability was severely curtailed by the large number of samples below the detection limit. This is evident on examination of Figures III-5, III-6, IV-5 and IV-6, which show mean concentrations over time in these samples. Table 11 gives the percent of positive samples (that is, samples with diazinon concentration above the detection limit) by treatment, depth, application and day. A loglinear model analysis of these data, paralleling the ANOVA's done on the surface soil data, was not feasible because such a large number of classifications had no positive samples.

Examination of Table 11 suggests that in fall 1984 there was a consistently higher percent positive at 0-15 cm than at 15-30 cm, that at both depths the percentage decreased over days within each application, and that for the shallow depth there was a decreasing trend across applications. The results for spring 1985 are far less clear, in part because fewer samples were taken. For example, fluctuations between 0, 11 and 33% positive are less meaningful than they might appear, since 11% represents only one positive sample in a total of nine, and 33% represents two positive samples in six. For this reason, the spring 1985 percentages should not be over-interpreted.

It is interesting to note that the overall percentage of positive samples in subsurface soil was much higher in fall 1984, while the overall concentrations of diazinon in turf and surface soil were higher in spring 1985 (Figures III-5 and -6 and IV-5 and -6 show that concentrations in the positive subsurface samples were also higher in fall 1984). This suggests the possibility that the lower concentrations in turf and surface soil in fall 1984 were due to more of the material moving into the subsurface soil.

Table VII-1. Analysis of variance results for concentration of diazinon (In mg/m^2) in turf/thatch samples, fall 1984 and spring 1985. The ANOVA factors were treatments (fall 1984, spring 1985), applications (1,2 and 3) and days post application (1, 5 and 9).

Source of Variance	Degrees of Freedom	Type III Sum of Squares	F Statistic	p-Value	Error Term
1 Treatment	1	35.66	7.35	0.0351	2
2 Site (Treatment)	6	29.13	8.75	0.0001	Residual
3 Day	2	79.67	17.50	0.0003	5
4 Trmt X Day	2	6.87	1.51	0.2605	5
5 Day X Site (Trmt)	12	27.31	4.10	0.0001	Residual
6 Application	2	40.22	5.51	0.0201	8
7 Trmt X Application	2	17.76	2.43	0.1298	8
8 Appl X Site (Trmt)	12	43.80	6.58	0.0001	Residual
9 Appl X Day	4	9.93	1.63	0.2048	11
10 Trmt X Appl X Day	4	5.51	0.91	0.4788	11
11 ApplXDayXSite(Trmt)	20	30.37	2.74	0.0003	Residual
Residual	136	75.42			

Table VII-2. Analysis of variance results for concentration of diazinon (in mg/m^2) in turf/thatch samples, fall 1984, Japanese Beetle Project, Sacramento, 1983-6. The ANOVA factors were applications (1,2 and 3) and days post application (1,5,9 and 13).

Source of Variance	Degrees of Freedom	Type III Sums of Squares	F Statistic	p-Value	Error Term
1 Day	3	181.10	23.33	0.0001	5
2 Application	2	15.52	3.50	0.0809	6
3 Application X Day	6	20.44	1.77	0.1566	7
4 Site	4	14.65	6.18	0.0002	Residual
5 Day X Site	12	31.05	4.36	0.0001	Residual
6 Appl X Site	8	17.74	3.74	0.0007	Residual
7 Appl X Day X Site	20	38.48	3.24	0.0001	Residual
Residual	112	66.45			

Table VII-3. Analysis of variance results for concentration of diazinon (in mg/m^2) in turf/thatch samples, final applications, fall 1984 and spring 1985, Japanese Beetle Project, Sacramento, 1983-6. The ANOVA factors were treatment (fall 1984, spring 1985) and days post third application (1,5,9,13,17 and 21).

Source of Variance	Degrees of Freedom	Type III Sums of Squares	F Statistic	p-Value	Error Term
1 Treatment	1	9.72	0.51	0.5001	2
2 Site (Treatment)	6	113.31	48.22	0.0001	Residual
3 Day	5	213.16	27.95	0.0001	5
4 Trmt X Day	5	11.26	1.48	0.2268	5
5 Day X Site (Trmt)	30	45.76	3.89	0.0001	Residual
Residual	96	37.60			

Table VII-4. Analysis of variance results for concentration of dislodgable diazinon (in mg/m^2) in turf/thatch samples, final applications, Fall 1984 and Spring 1985; Japanese Beetle Project, Sacramento, 1983-6. The ANOVA factors were treatment (fall 1984, spring 1985) and days post third application (1,5,9,13 and 17).

Source of Variance	Degrees of Freedom	Type III Sums of Squares	F Statistic	p-Value	Error Term
1 Treatment	1	31.81	2.30	0.1800	2
2 Site (Trmt)	6	82.93	28.43	0.0001	Residual
3 Day	4	184.63	29.73	0.0001	5
4 Trmt X Day	4	6.00	0.97	0.4439	5
5 Day X Site (Trmt)	24	37.26	3.19	0.0001	Residual
Residual	80	38.89			

Table VII-5. Analysis of variance results for concentration of diazinon (in mg/m^2) in soil samples (0-2.5 cm), fall 1984 and spring 1985; Japanese Beetle Project, Sacramento, 1983-6. The ANOVA factors were treatment (fall 1984 and spring 1985), application (1,2 and 3) and days post application (1,5 and 9).

Source of Variance	Degrees of Freedom	Type III Sums of Squares	F Statistic	p-Value	Error Term
1 Treatment	1	48.54	3.25	0.1213	2
2 Site (Treatment)	6	89.52	19.45	0.0001	Residual
3 Day	2	115.03	25.07	0.0001	5
4 Trmt X Day	2	17.55	3.83	0.0518	5
5 Day X Site (Trmt)	12	27.53	2.99	0.0001	Residual
6 Application	2	35.15	2.75	0.1041	8
7 Trmt X Application	2	14.86	1.16	0.3457	8
8 Appl X Site (Trmt)	12	76.72	8.33	0.0001	Residual
9 Appl X Day	4	17.38	1.98	0.1370	11
10 Trmt X Appl X Day	4	11.11	1.26	0.3168	11
11 ApplXDayXSite(Trmt)	20	43.96	2.86	0.0002	Residual
Residual	136	104.33			

Table VII-6. Analysis of variance results for concentration of diazinon (In mg/m^2) in soil samples (0-2.5 cm), fall 1984; Japanese Beetle Project, Sacramento, 1983-6. The ANOVA factors were application (1,2 and 3), and days post application (1,5,9 and 13).

Source of Variance	Degrees of Freedom	Type III Sums of Squares	F Statistic	p-Value	Error Term
1 Day	3	214.82	73.03	0.0001	5
2 Application	2	92.87	20.97	0.0007	6
3 Appl X Day	6	9.97	0.73	0.6337	7
4 Site	4	65.83	20.61	0.0001	Residual
5 Day X Site	12	11.77	1.23	0.2731	Residual
6 Appl X Site	8	17.71	2.77	0.0078	Residual
7 Appl X Day X Site	20	45.76	2.87	0.0002	Residual
Residual	112	89.44			

Table VII-7. Analysis of variance results for concentration of diazinon (In mg/m^2) in soil samples (0-2.5 cm), final applications, fall 1984 and spring 1985; Japanese Beetle Project, Sacramento, 1983-6. The ANOVA factors were treatment (fall 1984, spring 1985) and days post third application (1,5,9,13 and 17).

Source of Variance	Degrees of Freedom	Type III Sums of Squares	F Statistic	p-Value	Error Term
1 Treatment	1	83.50	4.11	0.0890	2
2 Site (Treatment)	6	121.95	43.28	0.0001	Residual
3 Day	4	169.53	17.80	0.0001	5
4 Treatment X Day	4	11.12	1.17	0.3498	5
5 Day X Site (Trmt)	24	57.17	5.07	0.0001	Residual
Residual	80	37.56			